Hazus Flood Model User Guidance

August 2018

FEMA

Document History

Affected Section or Subsection	Date	Description
First publication using this format	August 2018	Updated user manual from Hazus version 2.1 to Hazus version 4.2 SP1. Manual has been reorganized from prior version.

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1 Introduction

The Hazus flood loss estimation methodology (Flood Model) provides local, state, and regional officials with a state-of-the-art decision support software for estimating potential losses from flood scenarios. This loss estimation capability will enable users to anticipate the consequences of future floods and to develop plans and strategies for reducing risk. The Geographic Information System (GIS)-based software can be applied to study small or large geographic areas with a wide range of population characteristics.

The Hazus methodology was developed for the Federal Emergency Management Agency (FEMA) by the National Institute of Building Sciences to provide a tool for developing earthquake loss estimates. Hazus has been expanded to perform similar loss evaluations for hurricane wind, flood, and tsunami.

If Hazus is applicable for all regions across the nation with flood risk, loss estimates would help guide the allocation of federal resources to stimulate risk mitigation efforts and plan for federal flood response.

This manual, Hazus Flood Model User Guidance (User Guidance), provides background and instructions on identifying the flood hazard, developing an inventory for a flood loss estimation study, how to use the model, run basic analyses, interpret results, and report model outputs.

The Hazus Flood Model Technical Guidance (Technical Guidance) comprises separate accompanying documents. It provides information on the default data, the origin of each type of inventory, and the methods of calculating losses by changing basic parameterizations.

This User Guidance and the Technical Guidance provide a comprehensive overview of the Flood Model.

1.1 Hazus Users and Applications

Hazus can be useful for a variety of users with a variety of data needs, including:

- A local or state government official may be interested in the costs and benefits of specific mitigation strategies and may want to know the expected losses if mitigation strategies have (or have not) been applied.
- Emergency response teams may use the results of a loss study in planning and performing emergency response exercises. In particular, they might be interested in the operating capacity of emergency facilities such as fire stations, emergency operations centers, and police stations.
- Emergency planners may want to know how much temporary shelter will be needed and for how long.
- Utility company representatives and community planners may want to know the locations and durations of potential utility outages.
- Federal and state government officials may require an estimate of economic losses (both short term and long term) in order to direct resources toward affected communities. In addition, government agencies may use loss studies to obtain quick estimates of

impacts in the hours and immediately following a flood to best direct resources to the disaster area.

- Insurance companies may be interested in monetary losses so they can assess asset vulnerability.

1.2 Flood Model Outputs

Table 1-1 lists the Flood Model outputs. See Chapter 8 for details on each type of output.

Examples of pre-flood applications of the outputs may include:

- The development of flood hazard mitigation strategies that outline policies and programs for reducing flood losses and disruptions; may involve elevating potential structures or examining areas for potential buyouts
- Anticipation of the nature and scope of response and recovery efforts, including identifying short-term shelter requirements and debris management requirements

Examples of post-event applications of the outputs may include:

- Projection of immediate economic impact assessments for state and federal resource allocation and support, including supporting the declaration of a state and/or federal disaster by calculating direct economic impact on public and private resources, local governments, and the functionality of the area
- Activation of immediate emergency recovery efforts, including provision of emergency housing shelters and initiating debris clean-up efforts
- Application of long-term reconstruction plans including the identification of long-term reconstruction goals, the institution of appropriate wide-range economic development plans for the entire area, allocation of permanent housing needs, and the application of land use planning principles and practices

Table 1-1: Flood Model Outputs

Output	Description
Flood Hazard Maps	• Flood depth • Agricultural products
General Building Stock (GBS)	• Damage by occupancy • Damage by building type • Damage by building count • Loss from building repair or replacement • Loss from contents • Loss from business inventory • Loss from rental income • Loss from relocation costs • Loss from business income loss • Loss from employee wage loss

Output	Description
Combined Wind and Flood Loss	• Loss by general occupancy • Loss by specific occupancy • Loss by general building type
Essential Facilities	• Loss from building repair or replacement • Loss from contents
User-Defined Facilities	• Loss from building repair or replacement • Loss from contents • Loss from business inventory
Transportation Systems	• Loss from damage to transportation system components
Utility Systems	• Loss from damage to utility system components
Agricultural Products	• Loss from damage to crops
Vehicles	• Vehicle damage counts • Loss from damage to vehicles
Debris	• Building debris generated by weight and type of material
Shelter	• Number of displaced households • Number of people requiring temporary shelter

Once the inventory has been developed, making modifications and running new analyses are simple tasks. The ease with which reports and maps can be generated makes the software useful for a variety of applications.

1.3 Assumed User Expertise

Users can be divided into two groups: model users (those who perform the study) and end users (those who use the study results). References to users in this manual include both groups.

The two groups normally consist of different people, but may consist of the same people. The more interaction between these two groups, the better the study. End users should be involved from the beginning of the study to ensure that the results are usable.

The model users who perform the study should have a basic understanding of flood risk and potential consequences.

A loss study will be performed by a representative team consisting of the following:

- Floodplain managers
- Structural engineers or architects
- GIS professionals
- Economists
- Sociologists

- Emergency planners
- Loss estimate users

These individuals are needed to develop flooding scenarios, develop and classify building inventories, provide and interpret economic data, provide information about the local population, and provide input on the types of loss estimates that are needed to fulfill the goals of the study.

If a local or state agency is performing the study, some of the expertise may be in-house. Personnel with relevant expertise are generally in departments such as building permits, public works, planning, public health, engineering, GIS, climatology, information technologies, finance, historic preservation, natural resources, and land records. Although in-house expertise may be readily available, the value of the participation by individuals from academic institutions, citizen organizations, and private industry cannot be underestimated.

1.4 When to Seek Help

The results of a loss estimation study should be interpreted with caution because default input values have a great deal of uncertainty.

If the loss estimation team does not include individuals with expertise in the areas described in Section 1.2, one or more consultants will likely be needed to help interpret the results. It is also advisable to retain objective reviewers with relevant expertise to evaluate the map and tabular data outputs. A floodplain manager, hydrologist, or hydraulic engineer may be needed to provide deterministic or probabilistic scenario data or review the software parameters.

If the user intends to modify the default inventory data or parameters, assistance will be required from an individual with relevant expertise. For example, if the user wishes to change the default percentages of foundation types in a region, a structural engineer with knowledge of regional design and construction practices would be helpful. Modifications to defaults in the economic loss models will require input from an economist.

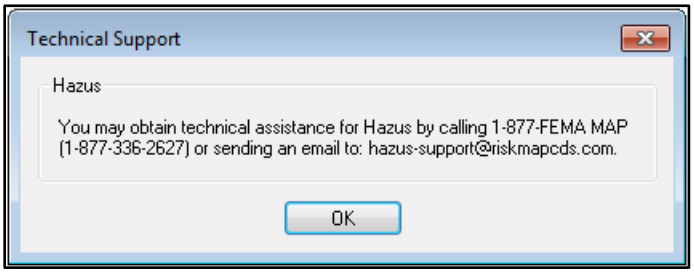
1.5 Technical Support

As shown in Figure 1-1 and provided in the Hazus application at **Help / Obtaining Technical Support**, technical assistance is available via the Hazus Help Desk at hazus-support@riskmapcds.com or 1-877-FEMA-MAP (1-877-336-2627). The websites for agencies and organizations listed in this document provide Frequently Asked Questions, software updates, training opportunities, and user group activities.

The application's **Help** menu references the help files for ArcGIS. Because Hazus was built as an extension to ArcGIS functionality, knowing how to use the ArcGIS and ArcGIS Help Desk will help Hazus users.

Technical support on any of the four hazards is available at the contacts shown in Figure 1-1 and via **Help** / **Obtaining Technical Support**.

Figure 1-1: Hazus Technical Support



1.6 Uncertainties in Loss Estimates

Although the software offers users the opportunity to prepare comprehensive loss estimates, even with state-of-the-art techniques, uncertainties are inherent in any estimation methodology. The Flood Model is only a tool for loss estimation from modeled flood events. Hazus does not compute uncertainties in the loss estimates, provide ranges for possible losses, or offer any confidence levels. The output of hard numbers is tied to the input data. Uncertainties may be estimated, but Hazus does not output such statistics.

1.7 Organization of User Guidance

This User Guidance provides information that will assist Flood Model users perform basic and advanced flood loss estimations.

Chapter 1: Introduction. Background on the Flood Model, Hazus applications, assumed user expertise, when to get help, technical support, and uncertainty in loss estimates.

Chapter 2: Overview of the Flood Model. Overview of the Flood Model for local, state, and regional officials contemplating a flood loss study. It describes riverine and coastal flood hazards in the Flood Model; types of buildings, facilities, and lifeline systems in the model; and the difference between a basic and advanced analysis.

Chapter 3: Getting Started I: Hazus Startup Screen. Description of the Hazus Startup screen with information about creating a new Study Region and how to open, delete, duplicate, export, and import existing Study Regions.

Chapter 4: Getting Started II: Basic Hazus Analysis. Introductory walk through of the Flood Model showing a user how to conduct a single-event riverine flood analysis.

Chapters 5, 6, 7, 8, and 9: Model Menus for Inventory, Hazard, Analysis, Results, and Other Items. Walk through of the Flood Model menus related to inventory, hazard, analysis, results, and other menu items.

Chapters 10, 11, and 12: Advanced Hazus Analysis. How to conduct an advanced flood analysis, including information on user-defined inventory data, importing user-defined hazard data, and combined wind and flood hurricane surge analysis.

Chapter 13: Quick Look and Enhanced Quick Look. Step-by-step instructions on how to perform Quick Look and Enhanced Quick Look analyses.

Chapter 14: Acronyms and Abbreviations.

Chapter 15: Glossary. Glossary of key terms.

2 Overview of the Flood Model

Chapter 2 provides an overview of the flood loss estimation methodology (Flood Model) and is intended for local, state, and regional officials contemplating a flood loss study. For more information on flood modeling approaches and assumptions (along with how uncertainties are addressed), consult the Technical Guidance.

The Flood Model will generate an estimate of the consequences to a county or region of a scenario flood (i.e., a flood of a specified magnitude). The loss estimate will describe the scale and extent of damage and the disruption that may result from a potential flood. The following information can be obtained:

- Quantitative estimates of losses in terms of direct costs for repair and replacement of damaged buildings and lifeline system components; direct costs associated with loss of function (e.g., loss of business revenue, relocation costs); people displaced from residences; quantity of debris; and regional economic impacts
- Functionality losses in terms of loss-of-function and restoration times for critical facilities, such as hospitals, and components of transportation and utility lifeline systems, and simplified analyses of loss-of-system-function for electrical distribution and potable water systems
- Extent of induced hazards in terms of exposed population and building value due to potential flooding and locations of hazardous materials

To generate this information, the methodology includes:

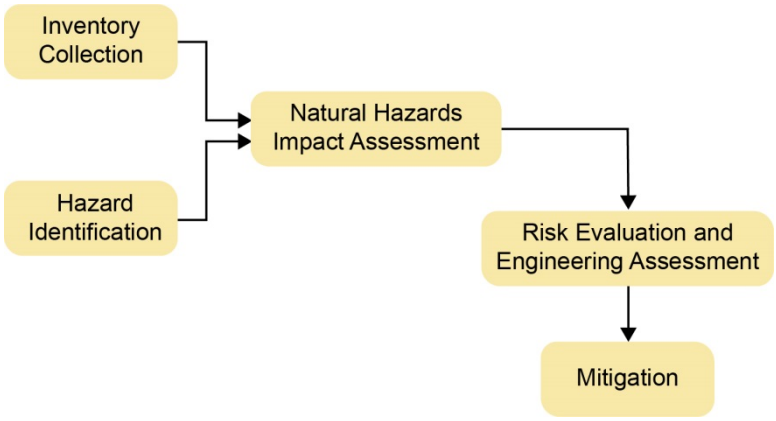
- Classification systems used in assembling inventory and compiling information on the general building stock (GBS), components of highway and utility lifelines, and demographic and economic data
- Standard calculations for estimating type and extent of damage, and for summarizing losses
- National and regional databases containing information for use as default (built-in) data, in the absence of user-supplied data (default data are useable in the calculation of losses)

These systems, methods, and data have been combined in user-friendly GIS software for this loss estimation application. GIS technology facilitates the manipulation of data on GBS, population, and the regional economy.

The software uses GIS technologies for displaying and manipulating inventory and displaying losses and consequences on applicable spreadsheets and maps. Collecting and entering the necessary information for analysis are the major tasks involved in generating a loss estimate. The methodology permits estimates to be made at several levels of complexity, based on the level of inventory entered for the analysis (i.e., default data versus locally enhanced data). The better and more complete the inventory information, the more accurate the results.

Figure 2-1 shows the conceptual steps that are typically performed in assessing and mitigating the impacts of a natural hazard such as a flood. The methodology incorporates inventory collection and hazard identification into the natural hazards impact assessment.

Figure 2-1: Conceptual Steps in Assessing and Mitigating Losses Due to Natural Hazards



While Figure 2-1 shows the conceptual steps in a natural hazard analysis, the steps used in the Flood Model are as follows:

- Select the area to be studied. The region of interest is created based on census tract, census block, county, state/territory, community, or watershed. The area generally includes a city, county, or group of municipalities. It is generally desirable to select an area that is under the jurisdiction of an existing regional planning group.
- Specify the hazard. In the Flood Model, the hazard can be specified as riverine, coastal, or a combination of riverine and coastal.
- Provide additional information describing the building inventory, or Essential Facilities, if available.
- Using formulas embedded in Hazus, Hazus computes expected building losses, expected contents losses, and expected loss-of-use for different classes of buildings.
- Hazus uses the above results to compute estimates of direct economic loss and short-term shelter needs.

The user plays a role in selecting the scope and nature of the output of a loss estimation study. A variety of maps can be generated for visualizing the extent of the losses. Numerical results may be examined at the level of the census tract or aggregated by county or region.

2.1 Flood Hazards in the Flood Model

The Hazus Flood Model analyzes both riverine and coastal flood hazards. Flood hazard is defined by a relationship between depth of flooding and the annual chance of inundation to that depth.

Depth, duration, and velocity of water in the floodplain are the primary factors contributing to flood losses. Other hazards associated with flooding that contribute to flood losses include channel erosion and migration, sediment deposition, bridge scour, and the impact of flood-borne

debris. The Hazus Flood Model allows users to estimate flood losses from depth of flooding. The agriculture component will allow the user to estimate a range of losses to account for flood duration. The Flood Model does not estimate the losses due to high-velocity flash floods.

Flood warning is one offsetting component to the primary flood damage factors identified above. The Flood Model allows the user to perform "what-if?" analyses to identify what percentage of losses avoided may make a warning system beneficial. This methodology follows the U.S. Army Corps of Engineers approach using the "Day" curves.

In different contexts, flood hazard may have different meanings. Hazard can mean risk in some contexts and it can mean a source of danger in others. The hazard may be that an area is inundated about once every 10 years (risk) or it may be that an area is subject to flood depths ranging from 5 to 10 feet (source of danger). Flood frequency studies combine these ideas and define flood hazard in terms of the chance that a certain magnitude of flooding is exceeded in any given year.

Flood magnitude is usually measured as a discharge value, flood elevation, or depth. For example, flood magnitude may be referred to as the 100-year flood elevation, which is the elevation, at the point of interest, that has a 1 percent annual chance of being exceeded by floodwater. Using the flood frequency convention, flood hazard is defined by a relation between depth of flooding and the annual chance of inundation greater than that depth. The relation is called a depth-frequency curve.

2.2 Types of Buildings, Facilities, and Lifeline Systems Considered

The buildings, facilities, and systems considered by the methodology are listed below. See the Technical Guidance for more information.

- General Building Stock (GBS) – Most commercial, industrial, and residential buildings are not considered individually when calculating losses. Instead, they are grouped into five general building types and 33 occupancy classes. Degrees of damage and loss are computed for each group.

  Examples of general building types include wood, steel, concrete, manufactured housing, and masonry.

  Examples of occupancy classes are single-family dwelling, retail trade, heavy industry, and churches.

  All structures that are evaluated in this manner are referred to as GBS.

- Essential Facilities – Essential Facilities, including medical care facilities, emergency response facilities and schools, are those vital to emergency response and recovery following a disaster. School buildings are included in this category because of the role they often play in housing displaced people. Generally, there are few Essential Facilities in a census tract, making it easier to obtain site-specific information for each facility. Thus, damage and loss-of-function are evaluated on an individual building basis even though the uncertainty in each estimate is large.

- User-Defined Facilities (UDFs) – UDFs are buildings at specific locations that are added to the inventory. This site-specific or structure based analysis allows for specific loss and

damage information to be calculated for each individual building, thus improving the accuracy of the results.

- Lifeline Systems – The Flood Model includes analysis for transportation and utility systems. Transportation system components analyzed include bridges for highways and railways, facilities associated with highways, railways, light rail, bus, port, ferry, and airport locations. Utility system components analyzed include portable water, waste water, natural gas, electric power, and communications locations.

2.3 Levels of Analysis

Hazus is designed to support two general types of analysis (Basic and Advanced) split into three levels of data updates (Levels 1, 2, and 3). Figure 2-2 provides a graphic representation of the various levels of analysis.

2.3.1 Basic Analysis

Level 1

A Basic Level 1 analysis is the simplest type of analysis requiring minimum effort by the user. It is based primarily on data provided with the software (e.g., census information, broad regional patterns of foundation distributions, no floodplain code adoption). The user is not expected to have extensive technical knowledge. While the methods require some user-supplied input to run, the type of input required could be gathered by contacting government agencies or by referring to published information. At this level, estimates are generalized and will be appropriate as initial loss estimates to determine where detailed analyses are warranted.

2.3.2 Advanced Analysis

Level 2

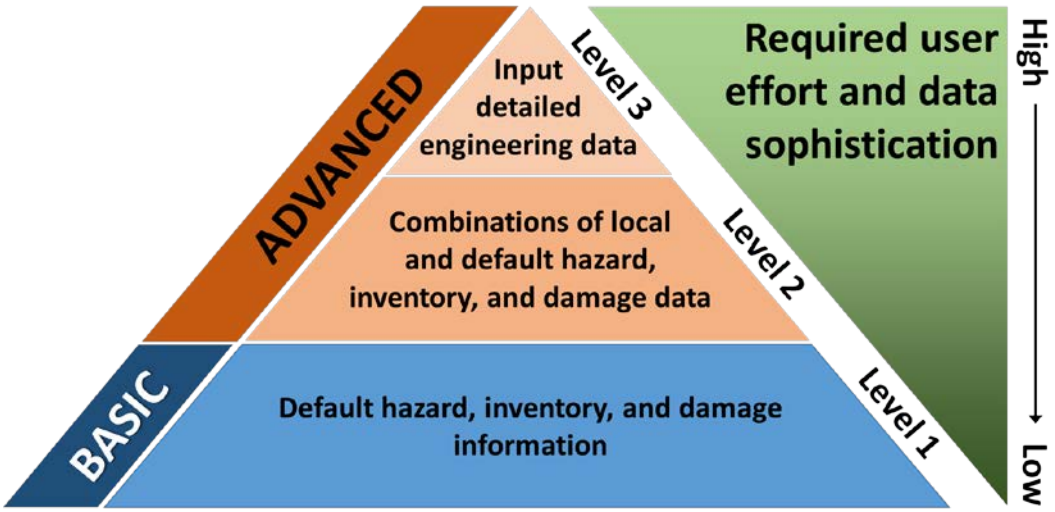
An Advanced Level 2 analysis improves Level 1 results by considering additional data that are readily available or can be easily converted or computed to meet methodology requirements. In Level 2, the user may need to determine parameters from published reports or maps as input to the model. It requires more extensive inventory data and effort by the user than a Basic Level 1 Analysis. The purpose of this type of analysis is to provide the user with the best estimates of hazard input data that can be obtained using the standardized methods of analysis included in the methodology. For example, user-supplied flood depth grids should be used over the internal Hazus hydrologic and hydraulics model. Hazus User Manuals provide detailed instructions on how to perform various type of Advanced Level 2 analysis.

Level 3

An Advanced Level 3 analysis requires effort by the user to develop and update information concerning the underlying engineering and loss analysis parameters in Hazus. This type of analysis incorporates results from engineering and economic studies carried out using methods and software not included within the methodology. At this level, one or more technical subject matter experts are required to acquire data, perform detailed analyses, assess damage/loss, and assist the user in gathering extensive inventory data. There are no standardized Advanced Level 3 analysis approaches. Users must understand where, within the Hazus software, to

change the underlying engineering and loss parameters used for an analysis. The quality and detail of the results will depend on the level of effort.

Figure 2-2: Levels of Hazus Analysis



2.4 Analysis Considerations for Flood Model

2.4.1 Analysis Based on Default Information

The basic level of analysis uses the default GBS and Essential Facility databases that are built into the model and extracted for a specific Study Region. These databases are derived from national-level data sources for building square footage, building value, population characteristics, costs of building repair, and economic data. Direct economic and social losses associated with the GBS are computed, along with Essential Facility functionality, short-term shelter requirement, and debris. The uncertainties are large; therefore, the analysis involves only default data sources.

In an analysis based on default data, the user's effort is limited to defining the Study Region, specifying the hazard (probabilistic or deterministic), and deciding the extent and format of the output. However, since default rather than actual data are used to represent local conditions, limitations exist in the estimated levels of damage and losses. An analysis based on default data is suitable primarily for preliminary evaluations and regional comparisons. It is always recommended that users import custom or user-defined flood depth grids when available.

2.4.2 Analysis with User-Supplied Inventory Data

The results from an analysis using only default inventory can be improved greatly by inputting at least a minimum amount of locally developed data. Such an analysis is what is intended. Improved results are highly dependent on the quality and quantity of improved inventories. The significance of the improved results also relies on the user's analysis priorities. The following inventory improvements impact the accuracy of analysis results:

- Use of locally available data or estimates concerning the square footage and counts of buildings in different occupancy classes
- Use of local expertise to modify, primarily by judgment, the databases concerning percentages of foundation types associated with different occupancy classes
- Preparation of a detailed inventory for all Essential Facilities
- Collection of detailed inventory and cost data to improve evaluation of losses and lack of function in various transportation and utility lifelines
- Use of locally available data concerning construction costs or other economic parameters
- Development of flood inundation maps
- Gathering of information concerning high potential loss facilities and facilities housing hazardous materials
- Synthesis of data for modeling the economy of the Study Region used in calculation of indirect economic impacts

3 Getting Started I: Hazus Startup Screen

The **Hazus Startup** screen is the first screen users will see after launching Hazus.

3.1 Hazus Startup

Before running a loss estimation analysis, users must define a Study Region. The Study Region in Hazus is the geographic unit for which data are aggregated, the flood hazard is defined, and the analysis is carried out. Before starting, make sure that the appropriate state(s)'s Hazus data have been downloaded (http://msc.fema.gov/portal/resources/hazus) and extracted here: C:\HazusData\Inventory.

Hazus will prompt users to create a new region or import a previously created region. Users can also open, delete, duplicate, backup, or export an existing region.

3.2 Create New Region

In the **Hazus Startup** screen (Figure 3-1), users will take the first step in defining the Study Region. In Figure 3-1, **Create a new region** has been selected. Click **OK** to activate the window shown in Figure 3-2.

Click **Next** to open the window shown in Figure 3-3 and name the region in the first box (up to 18 characters, no spaces, and must not begin with a number). Enter a description of the region in the second box. This is especially helpful if multiple users will be accessing this region in the future. Click **Next**, which will open the window shown in Figure 3-4. Select **Flood** from the **Hazard Types** and click **Next**. This selection cannot be altered later.

Figure 3-1: Select Create a New Region in Hazus Startup

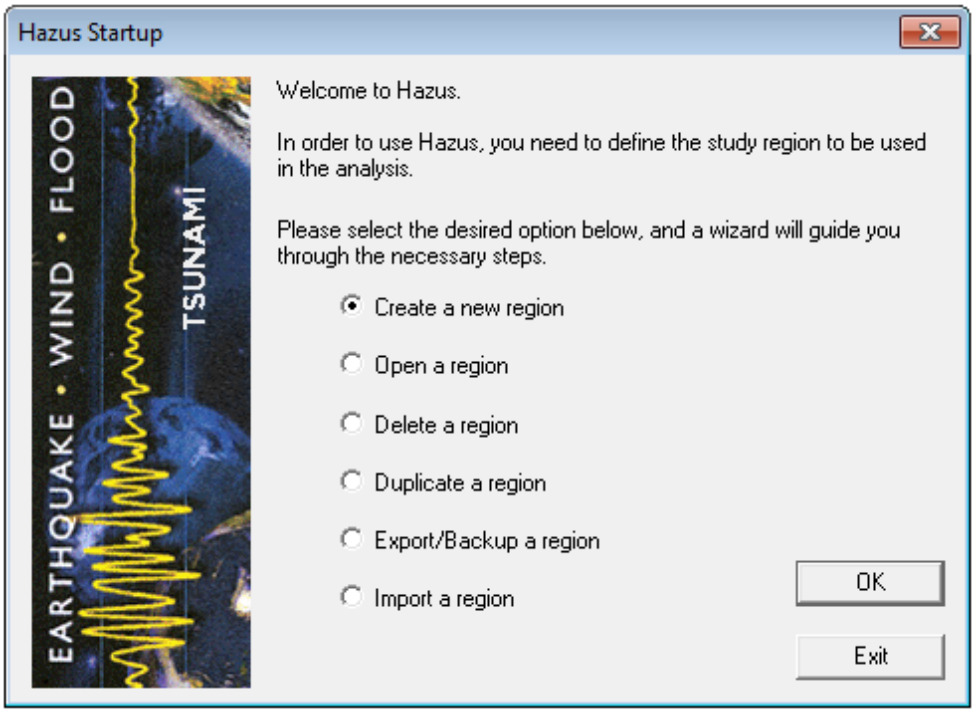


Figure 3-2: Select Create New Region in Wizard

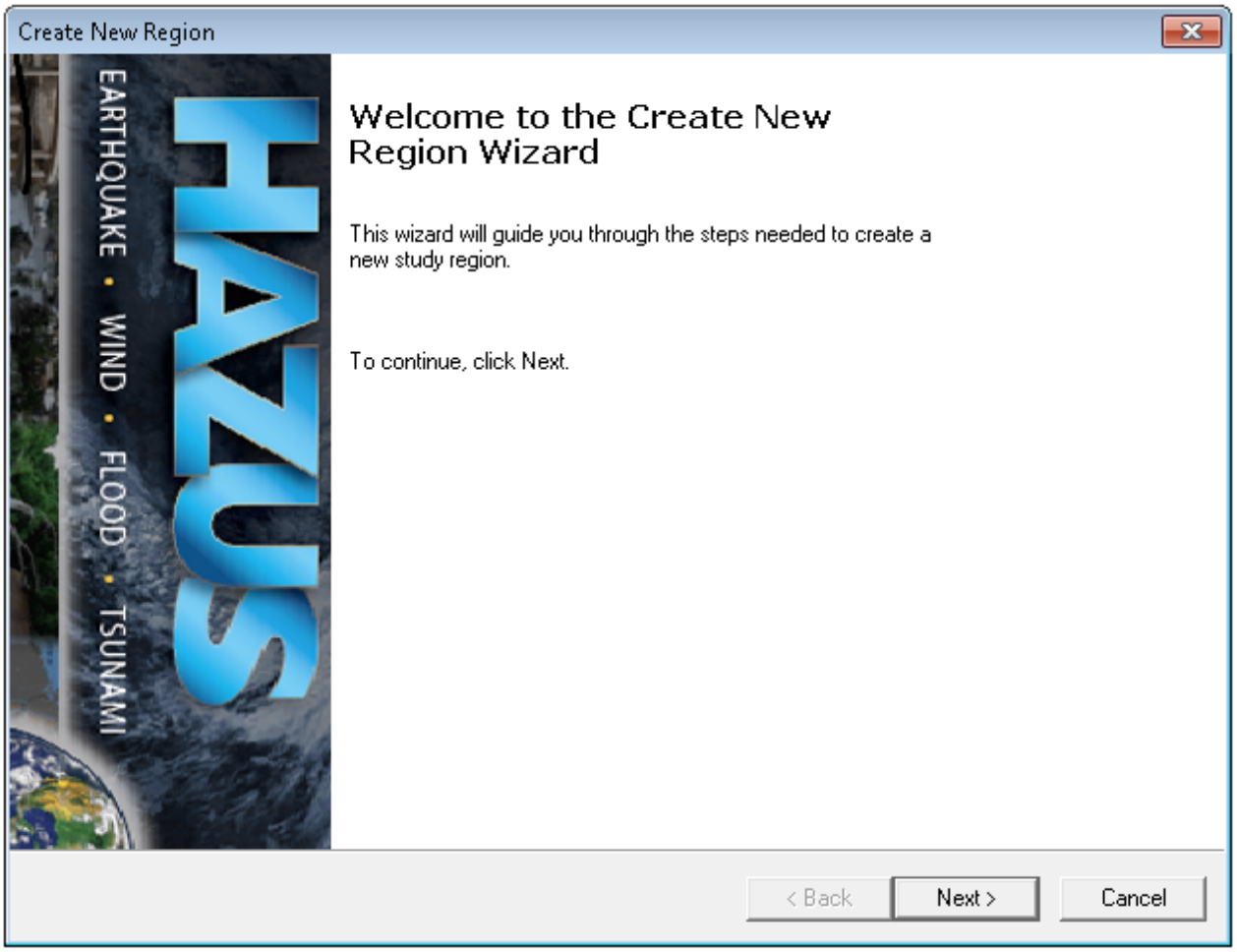


Figure 3-3: Create a Study Region Name

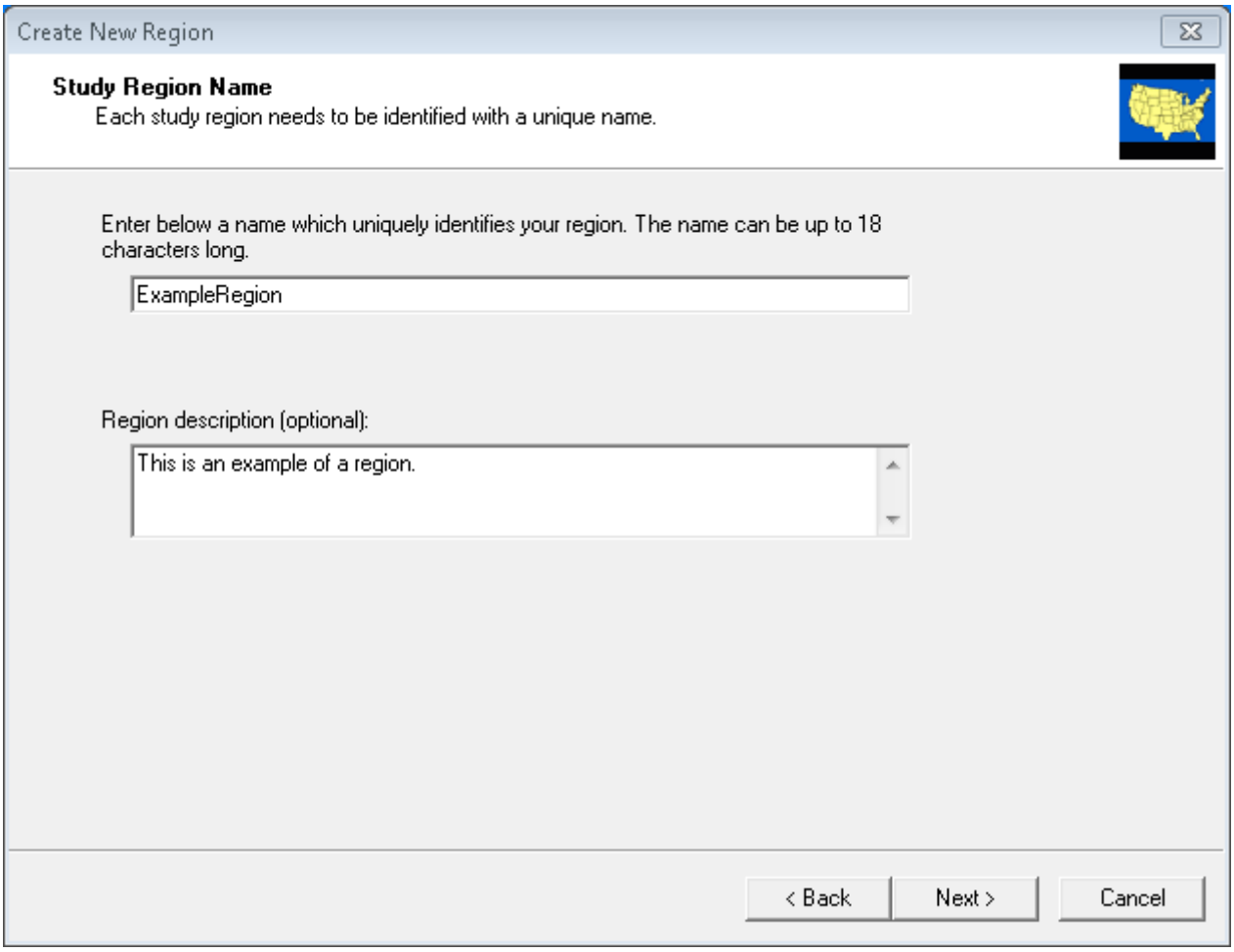
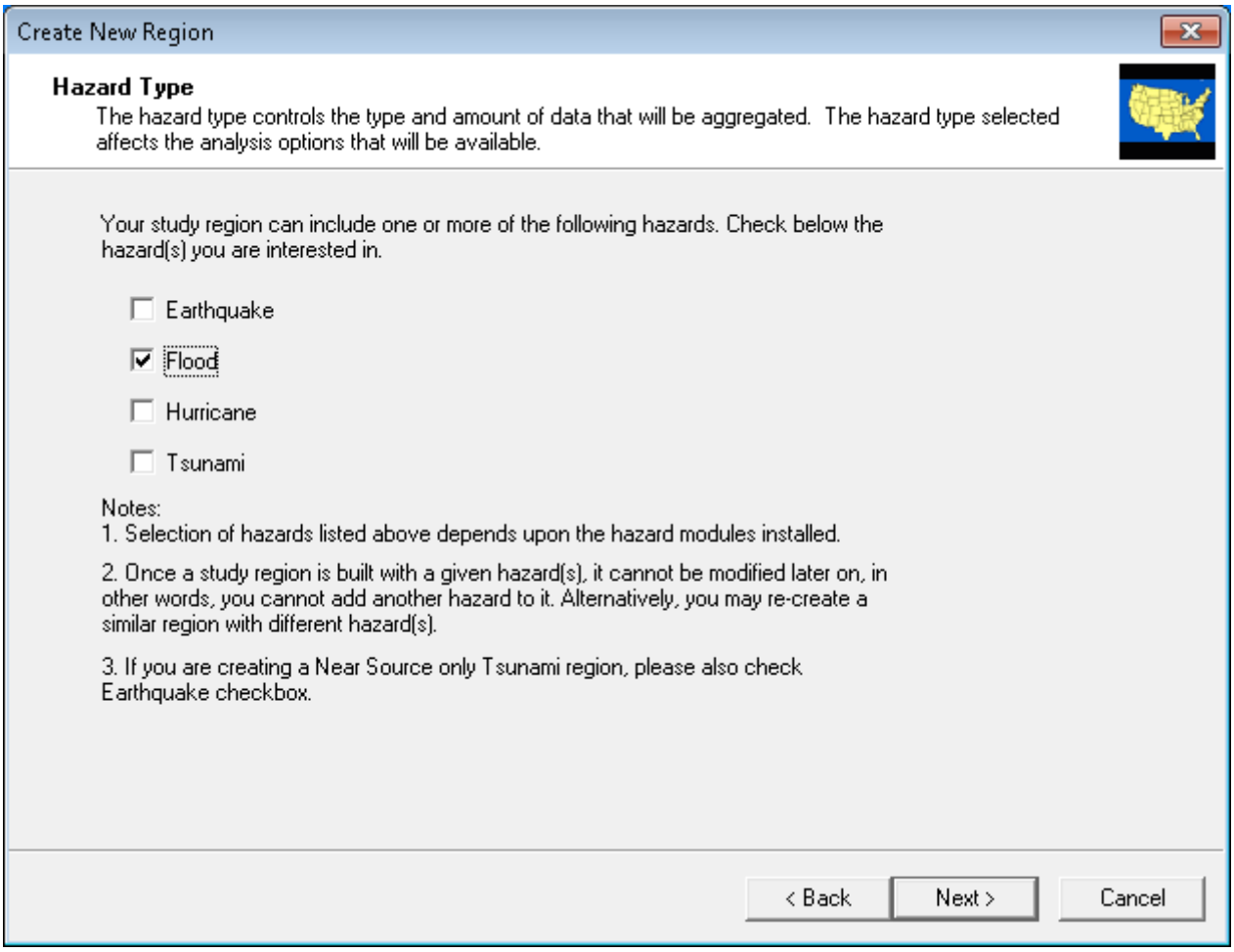


Figure 3-4: Select Hazard Type for New Region



From the window shown in Figure 3-5, select one of the six aggregation levels. Click **Next** to open the window shown in Figure 3-6. Select the state(s) covered by the Study Region. To select multiple states, hold the Shift key while making selections. Click **Next** to open the window in Figure 3-7. Select the county or counties covered by the Study Region.

Click **Nex**t to open the **Region Wizard Completion** notification shown in Figure 3-8. Click **Finish**. The status window shown in Figure 3-9 will appear. It may take several minutes for the region to be created. Once the process is finished, click **OK** to acknowledge the Study Region has successfully been created (Figure 3-10). The **Start Menu** will reappear.

Figure 3-5: Select Desired Aggregation Level

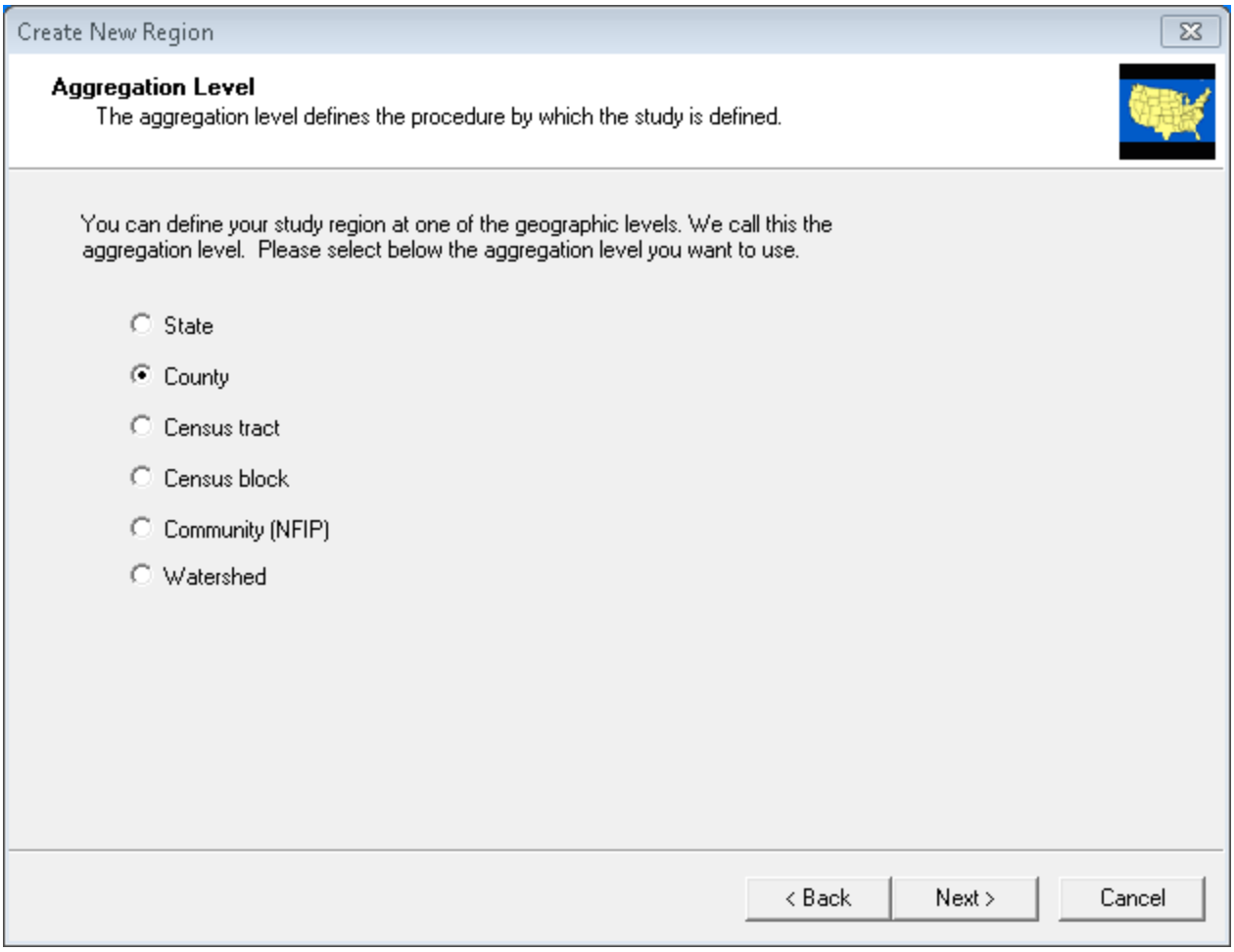


Figure 3-6: Select Appropriate State for the New Region

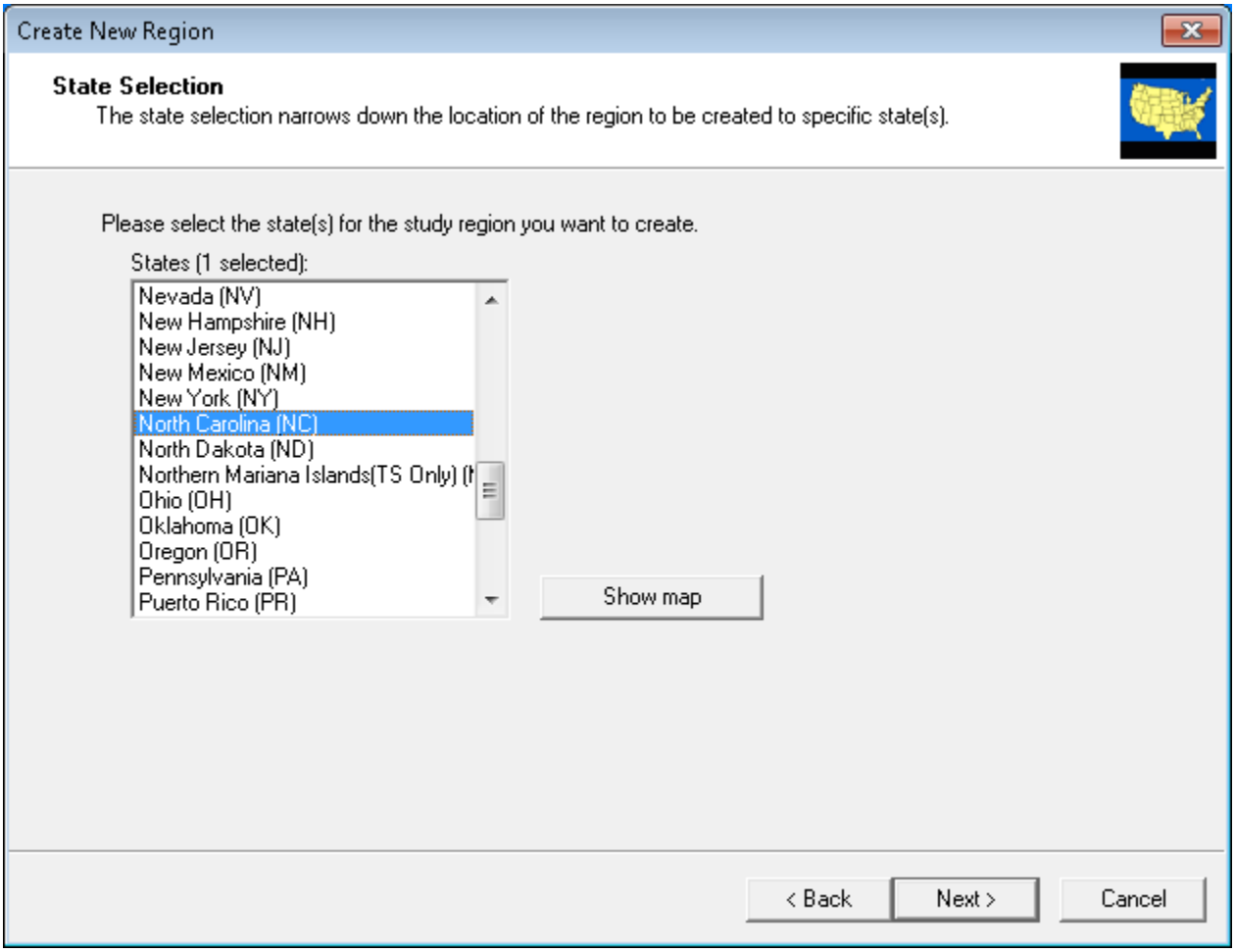


Figure 3-7: Select County for the New Region

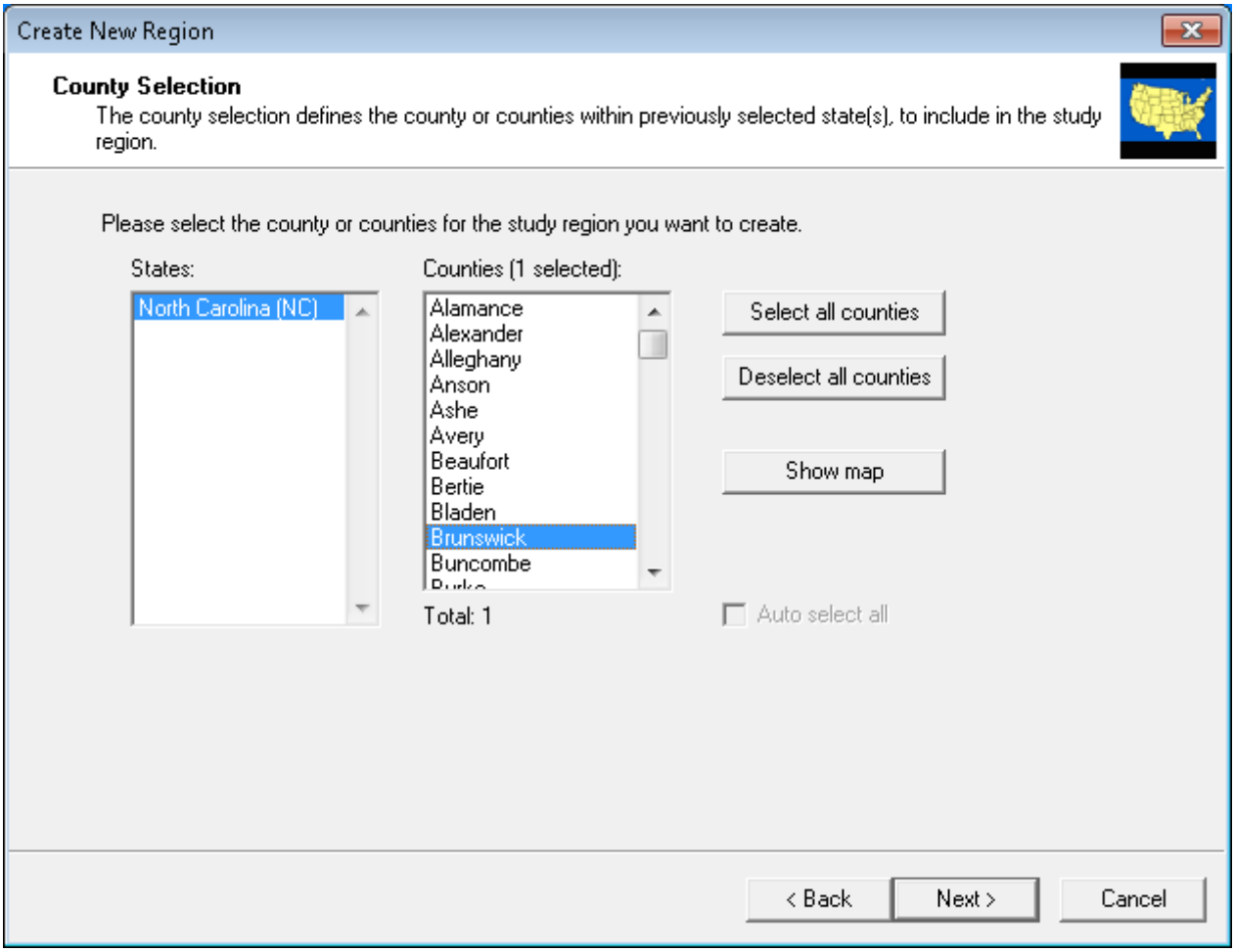


Figure 3-8: Create New Region Wizard Completion

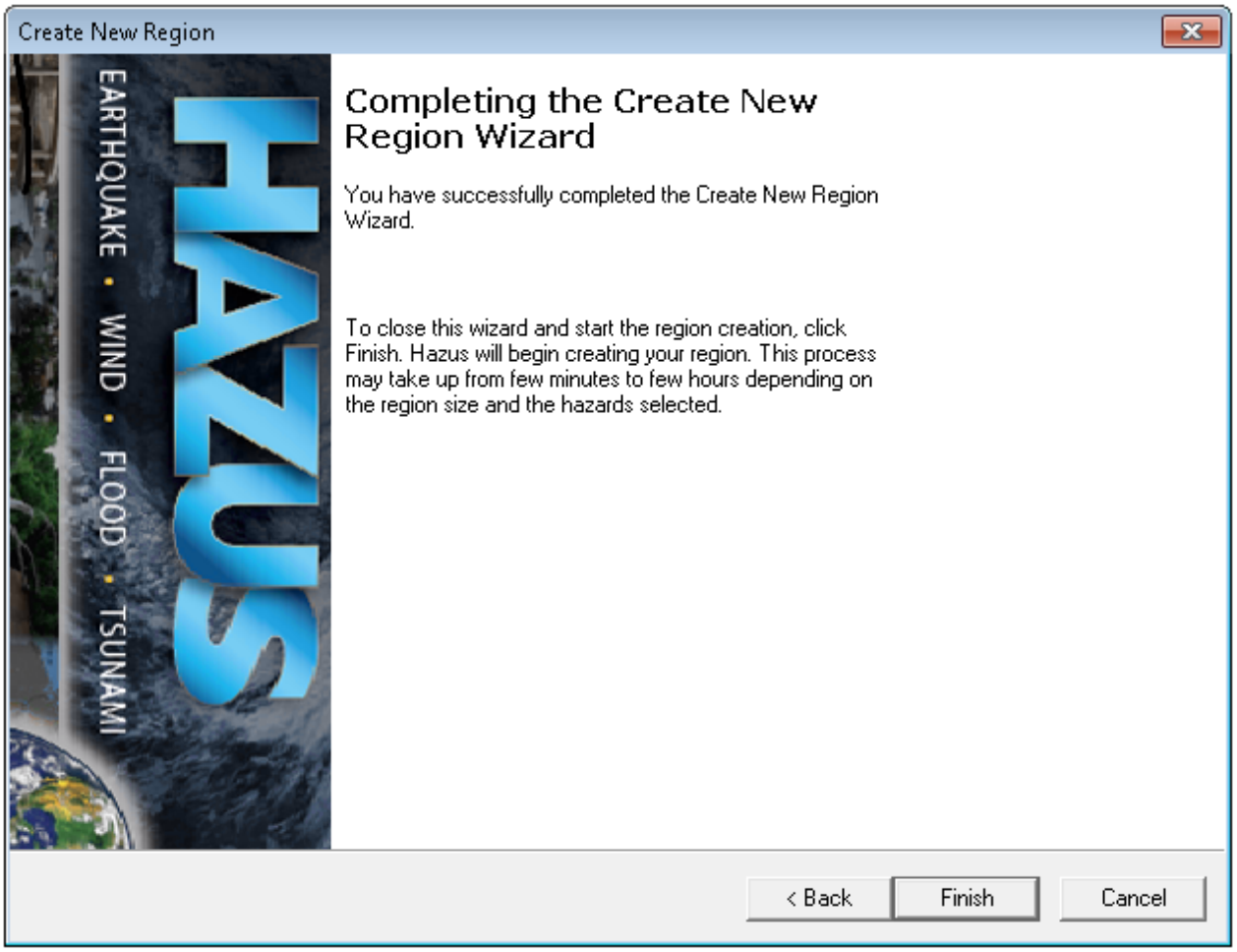


Figure 3-9: Create New Region Progress

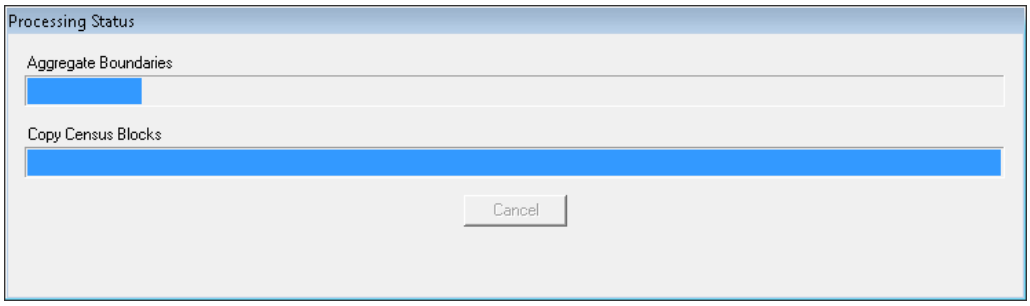
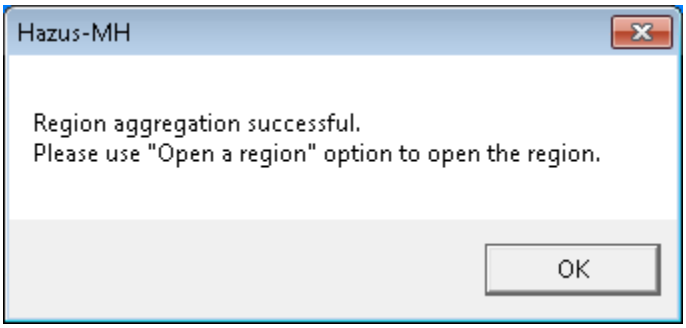


Figure 3-10: Create New Region Acknowledgement



3.3 Open Region

The **Open a region** option will not be available in the **Hazus Startup** screen in Figure 3-11 until a region has been created or imported. Select **Open a region** and click **OK**. The **Open Region Wizard** will appear (Figure 3-12). Click **Next**. An **Open Region** list will appear (Figure 3-13). Select which region should be opened. Click **Next**. Verify that the region name and hazard type are correct (Figure 3-14). Click **Finish**. Clicking **Finish** will launch ArcMap. Refer to the additional Hazus User Manuals for guidance.

Figure 3-11: Select Open a Region

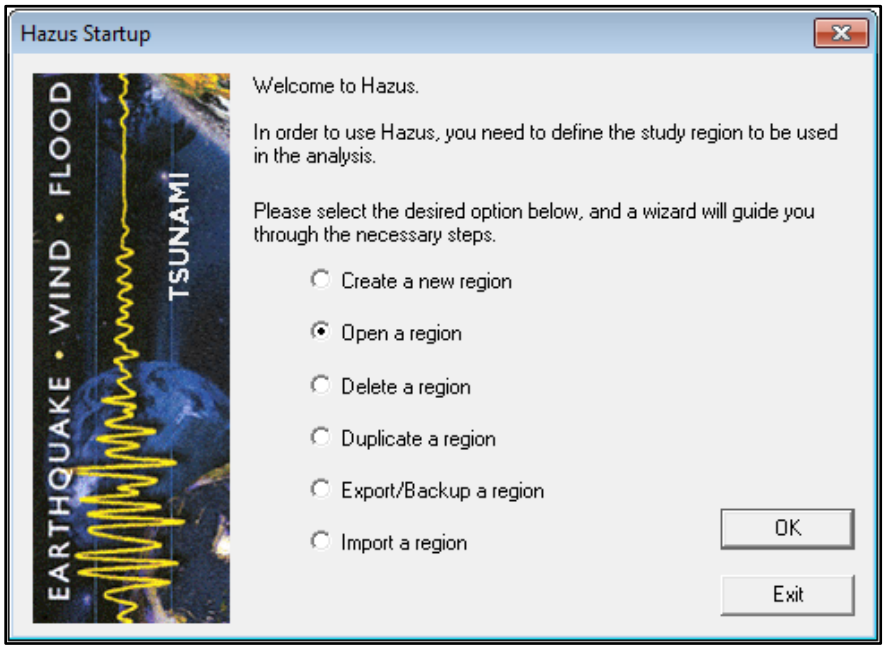


Figure 3-12: Open Region Wizard

Figure 3-13: Select the Region to Open

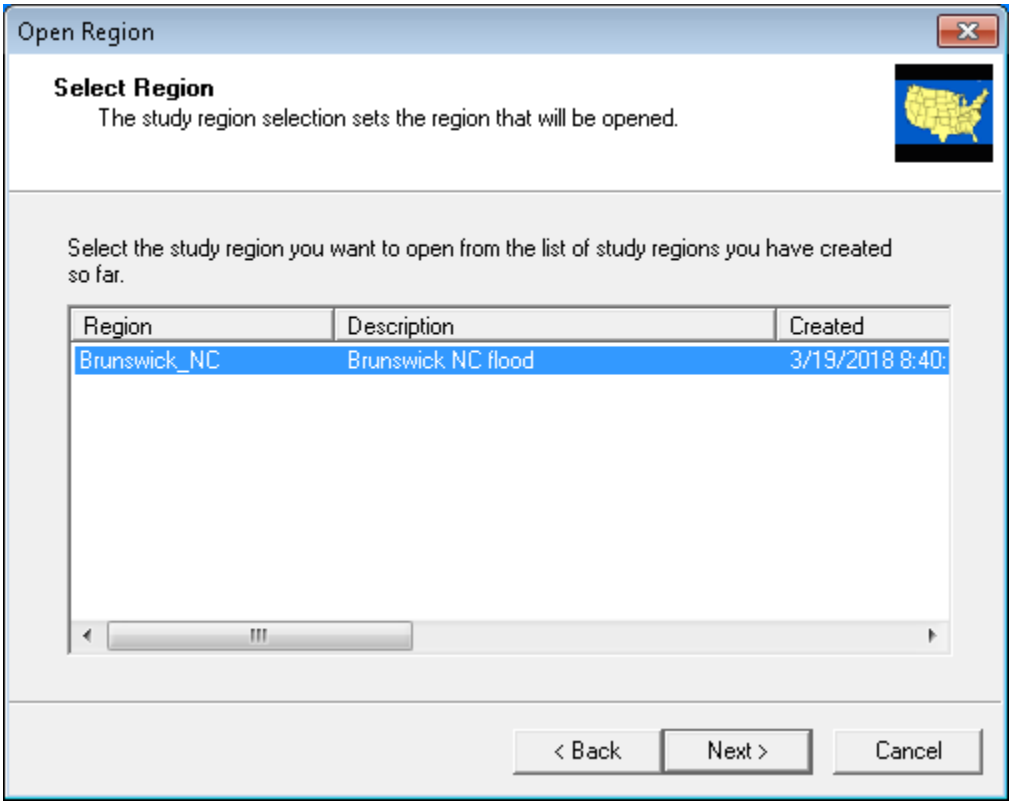


Figure 3-14: Open Region Wizard Completion

3.4 Delete Region

The **Delete a region** option will not be available in the **Hazus Startup** screen in Figure 3-15 until a region has been created or imported. Select **Delete a region** and click **OK**. A **Delete Region** list will appear (Figure 3-16). Select a region from the list and click **Delete** to permanently delete the region. The **Delete Region Confirmation** window will appear (Figure 3-17). Click **Yes** to delete or **No** to return to the **Delete Region** window (Figure 3-16). Click **Done** to close the window and return to the **Hazus Startup** screen.

Figure 3-15: Select Delete a Region

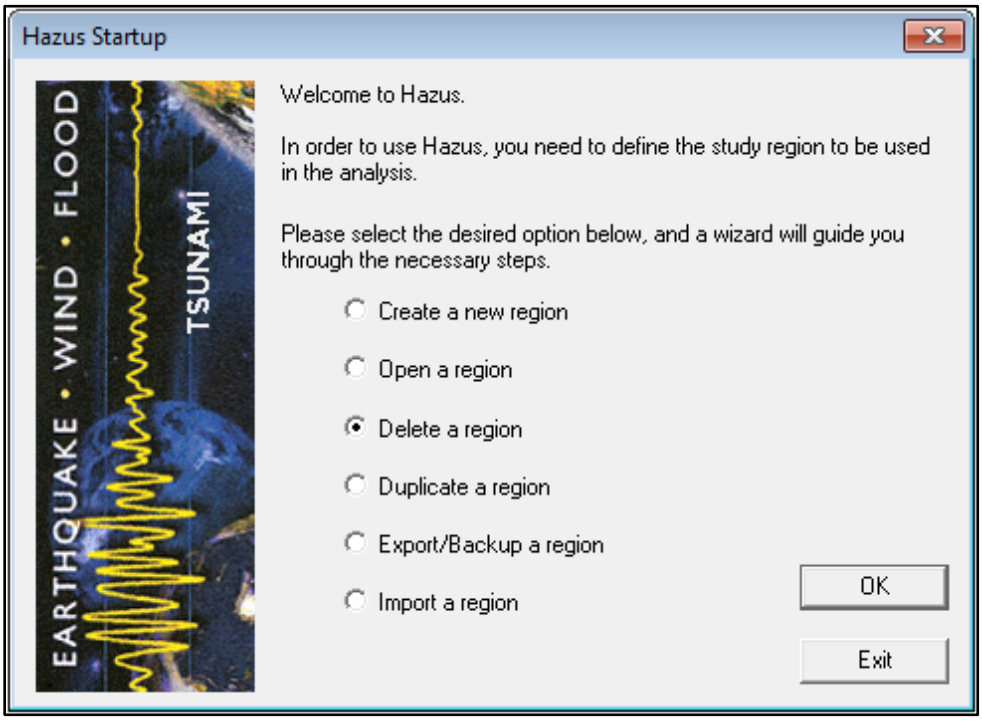


Figure 3-16: Select Region to Delete

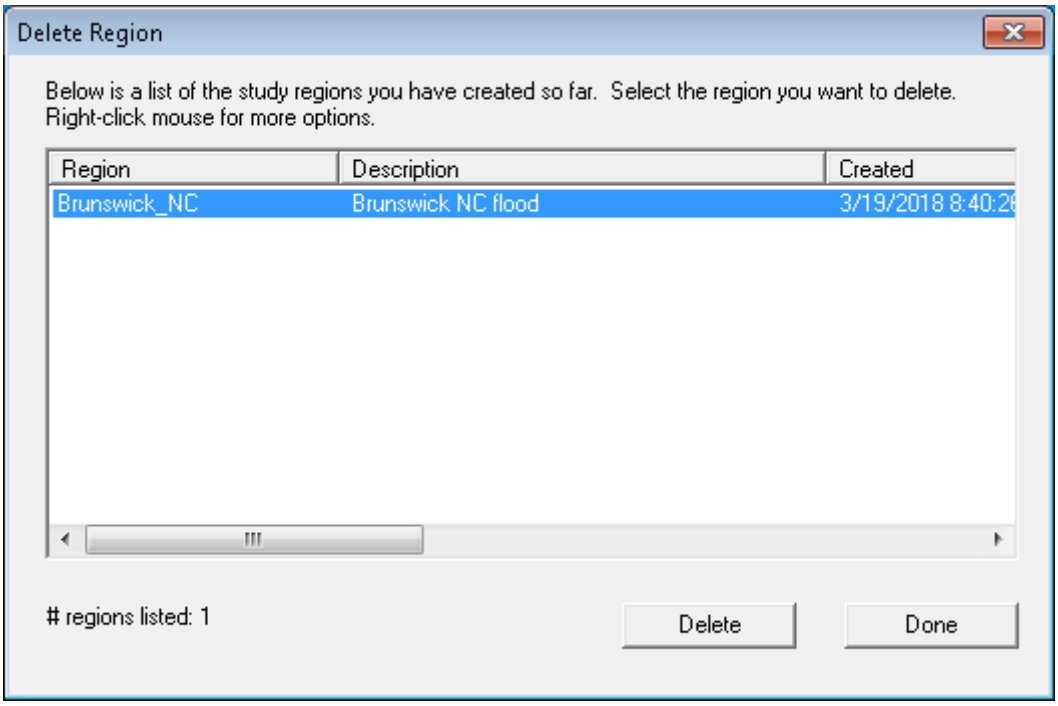
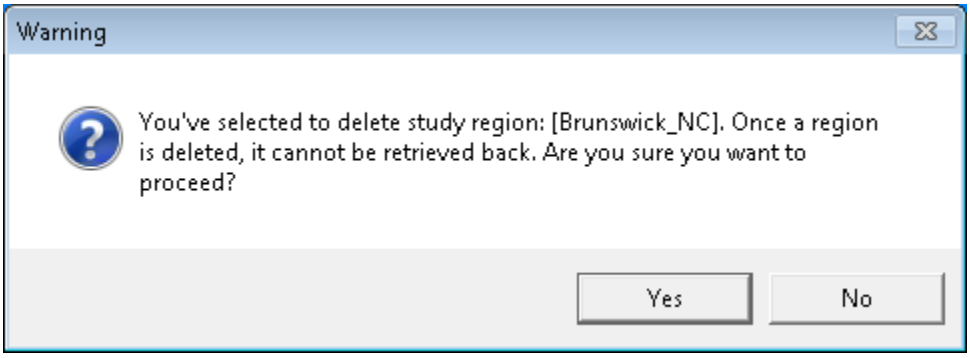


Figure 3-17: Delete Region Confirmation



3.5 Duplicate Region

The **Duplicate a region** option will not be available in the **Hazus Startup** screen in Figure 3-18 until a region has been created or imported. Select **Duplicate a region** and click **OK**. A **Duplicate Region** list will appear (Figure 3-19). Select the region from the list to be duplicated. Click **Duplicate**. A duplicate region confirmation window will appear (Figure 3-20). Click **Yes** to duplicate or **No** to return to the **Hazus Startup** screen (Figure 3-18).The **Duplicate Region Name** dialog will appear (Figure 3-21). Enter the name of the new region (18 characters and no spaces) and a brief description. Click **OK**. A progress bar will appear (Figure 3-22). It will close once the region has been successfully duplicated. This may take several minutes depending on the size of the region and the speed of the computer. A duplicate region completion notification (Figure 3-23) will appear to notify the user that the region has been duplicated. Click **OK** to return to the **Duplicate Region** list (Figure 3-19). Click **Done** to return to the **Hazus Startup** screen.

Figure 3-18: Select Duplicate a Region

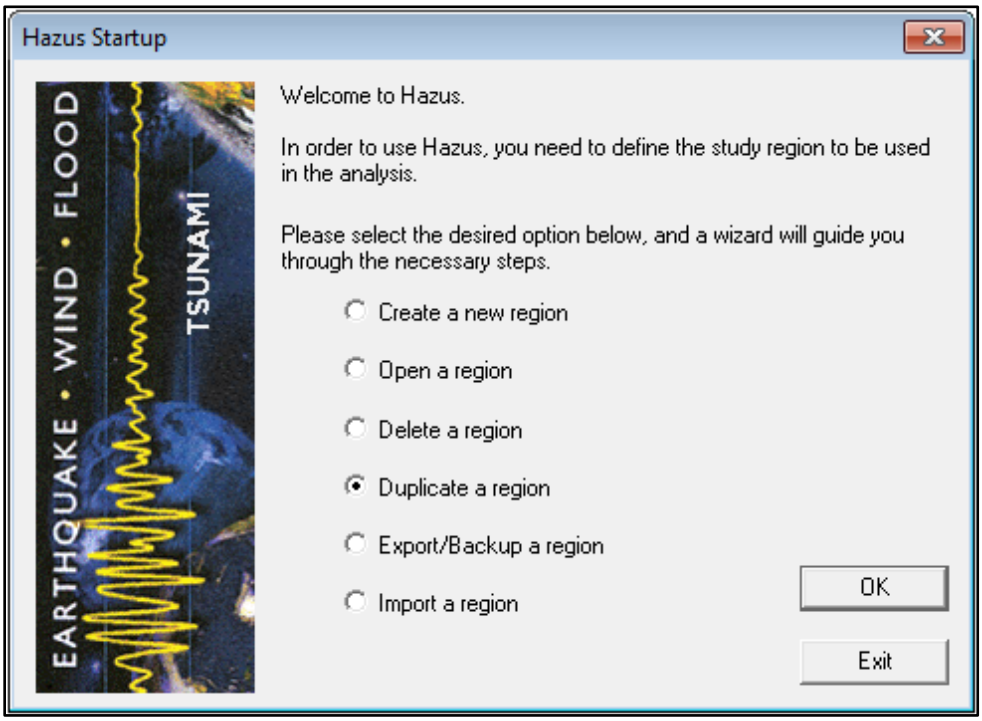


Figure 3-19: Select a Region to Duplicate

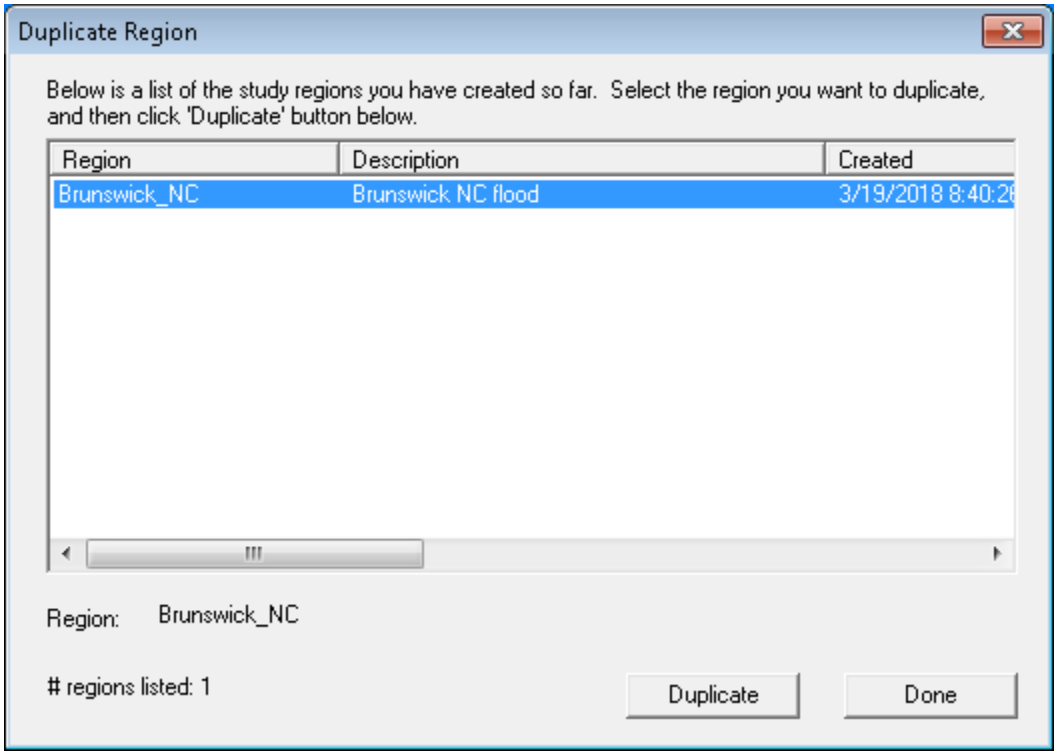


Figure 3-20: Duplicate Region Confirmation

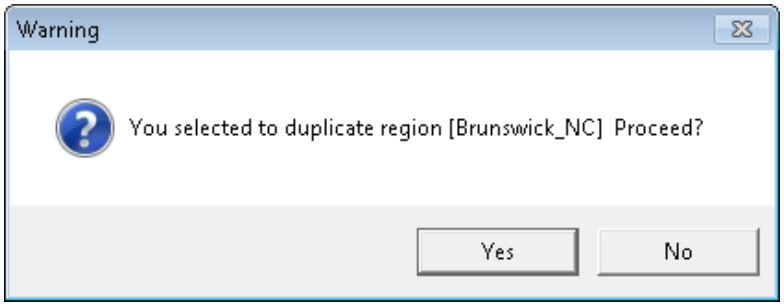


Figure 3-21: Provide Duplicate Region Name

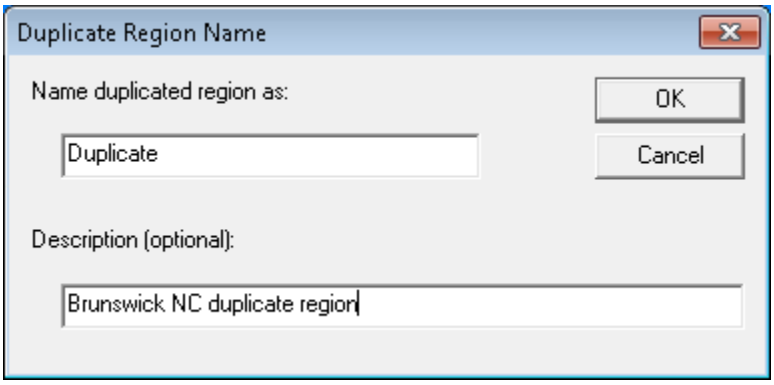


Figure 3-22: Duplicate Region Progress

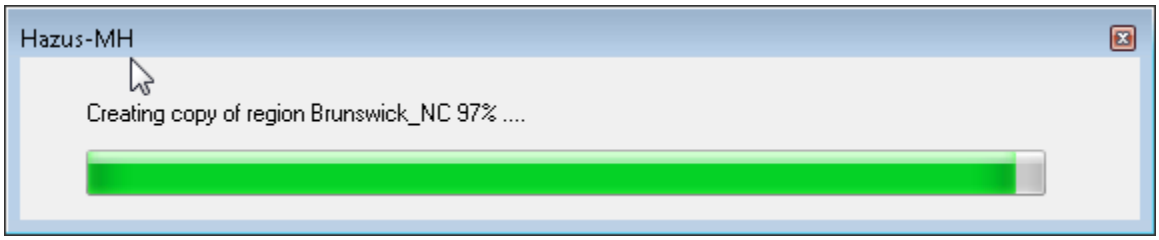
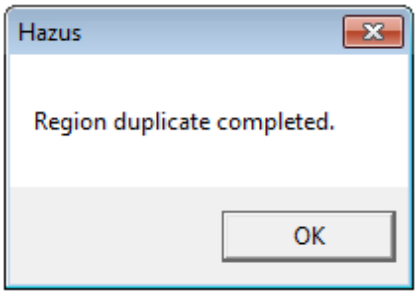


Figure 3-23: Duplicate Region Completed



3.6 Export/Backup a Region

The **Export/Backup a region** option will not be available in the **Hazus Startup** screen in Figure 3-24 until a region has been created or imported. Select **Export/Backup a region** and click **OK**. An **Export/Backup Region** list will appear (Figure 3-25). Select the region to export or backup from the list. Click **Browse** to select a file location to save the export/backup. Click **Export/Backup**. A progress bar (Figure 3-26) will appear. It will close once the region has been successfully exported. This may take several minutes depending on the size of the region and the speed of the computer. An **Export/Backup Region Completion** notification (Figure 3-27) will appear once the export has completed. Click **OK**.

Figure 3-24: Select Export/Backup a Region

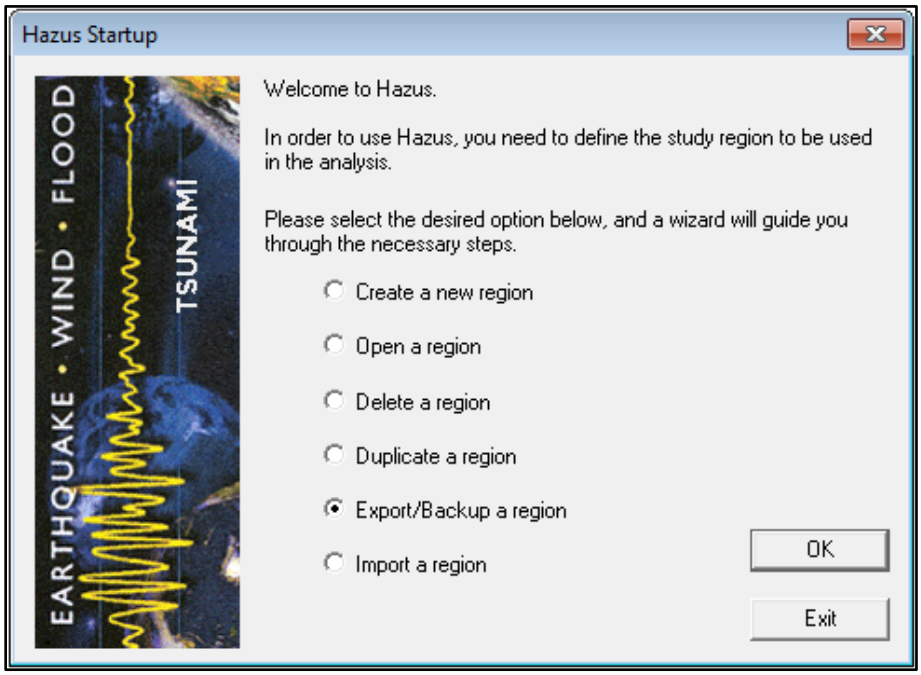


Figure 3-25: Select a Region to Export or Backup

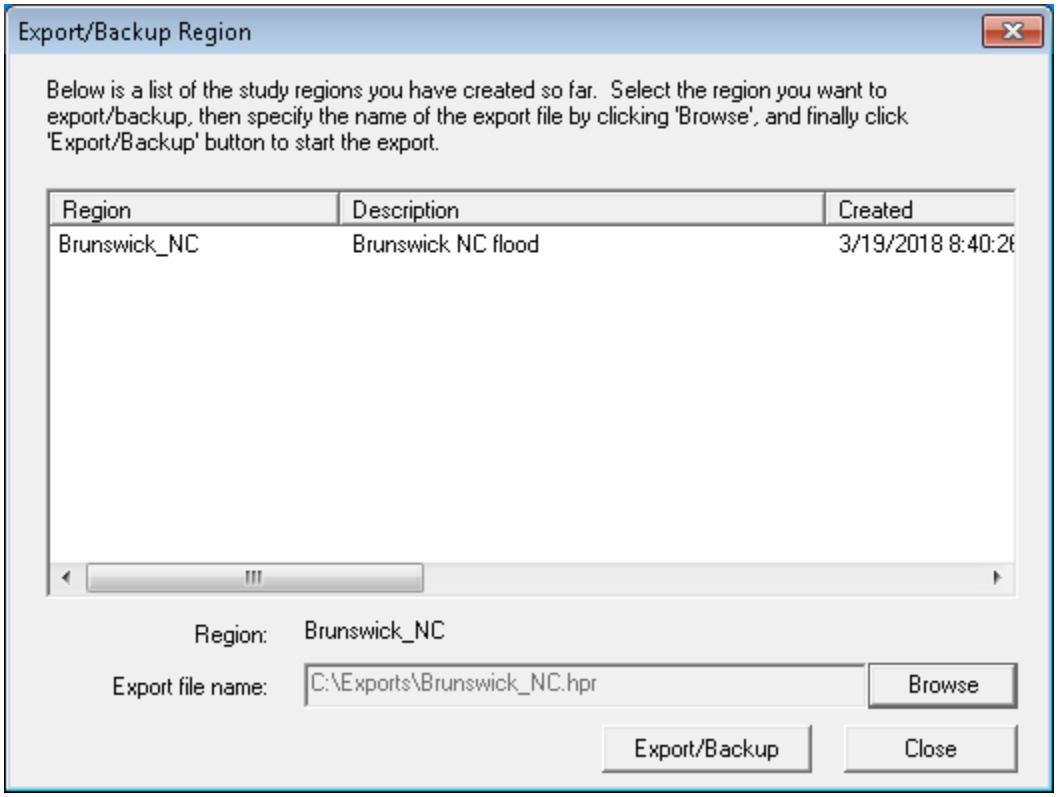


Figure 3-26: Export/Backup Region Progress

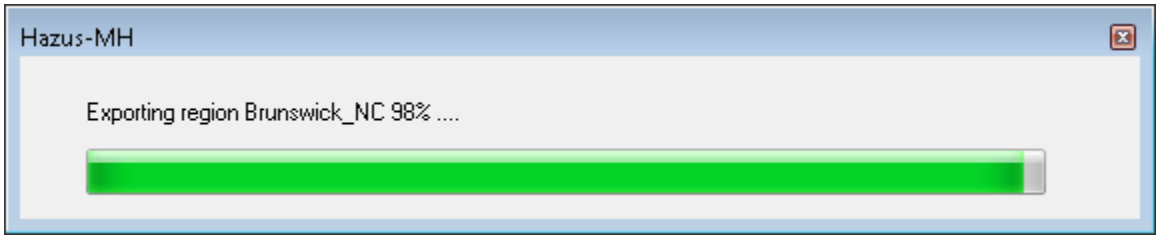
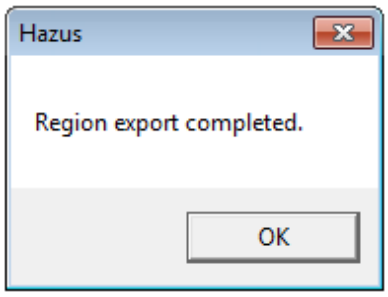


Figure 3-27: Export/Backup Region Completed



3.7 Import a Region

Select **Import a region** from the **Hazus Startup** screen in Figure 3-28 and click **OK**. Check the latest Hazus version release notes for limitations on importing from previous versions of Hazus. Hazus is backwards compatible only one version, so only Hazus 4.0 exported regions can be imported into Hazus 4.2 (there was no Hazus 4.1 release). A file explorer will open. Select an export Hazus Packaged Region (.hpr) file. In the **Imported Region Name** dialog (Figure 3-29), enter the name of the region (18 characters and no spaces) and a brief description. The name must be different than the imported .hpr file name. Click **OK**. A progress bar (Figure 3-30) will appear. It will close once the region has been successfully imported. This may take several minutes depending on the size of the region and the speed of the computer. A **Region Import Completion** notification will appear once the export has completed. Click **OK.**

Figure 3-28: Select Import a Region

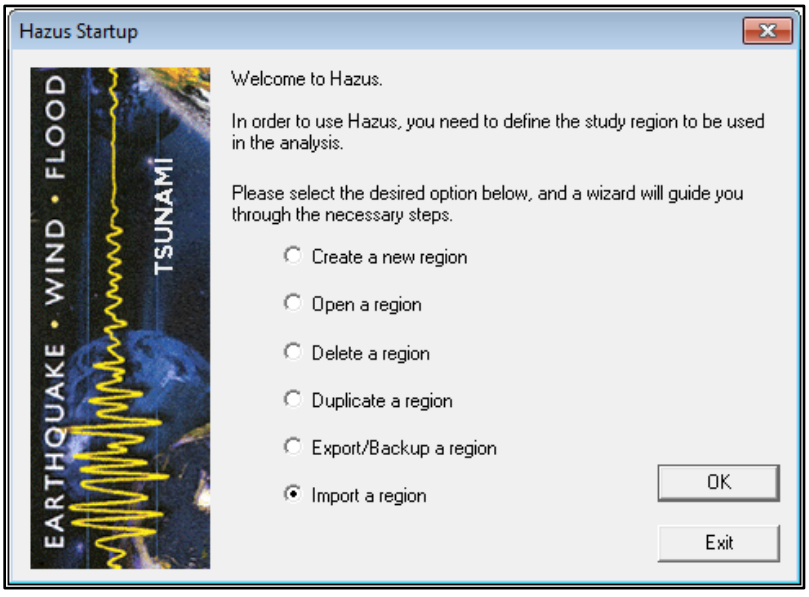


Figure 3-29: Provide the Name for the Imported Region

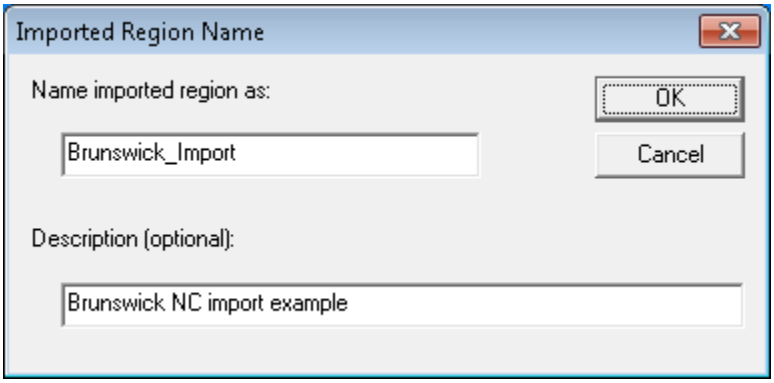


Figure 3-30: Import Region Progress

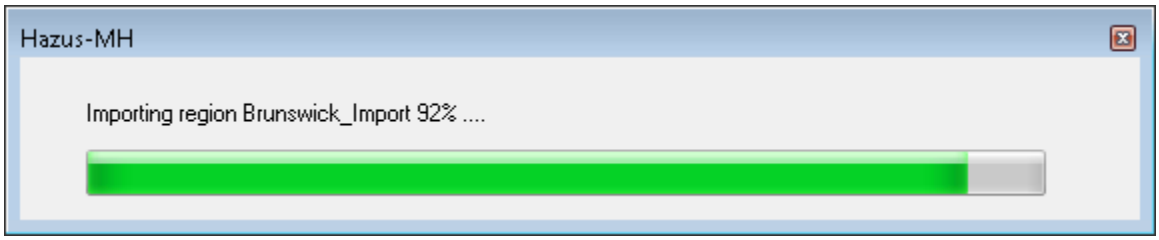
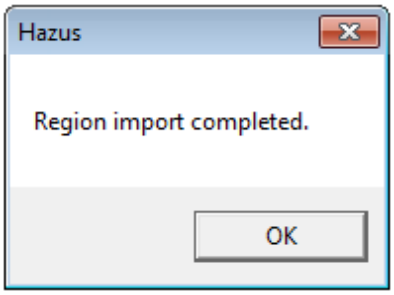


Figure 3-31: Region Import Completed



4 Getting Started II: Basic Hazus Analysis

The Flood Model allows practitioners to estimate the economic and social losses from flood events. The information provided by the model will help state and local officials evaluate, plan for, and mitigate the effects of flooding. The Flood Model provides practitioners and policy makers with a tool to help reduce flood damage, reduce disaster payments, and make wise use of the nation's emergency management resources.

Chapter 4 explains how to run a basic riverine Flood Level 1 GBS Analysis for a single flood event with flooding modeled by Hazus. This analysis makes use of census blocks that have been dasymetrically-adjusted based on land cover data, meaning that areas with land cover types that typically do not contain structures have been removed from the census block boundaries. Refer to the Flood Technical Manual for information on dasymetric census blocks and the methodology used by Hazus to produce the flood depth raster.

Launch Hazus and select **Open a Region** on the **Hazus Startup** screen (Figure 4-1). Information on the other options is provided in Chapter 3. Click **OK**, which will open the **Welcome to the Open Region Wizard** (Figure 4-2). Select **Next**.

Figure 4-1: Open a Region

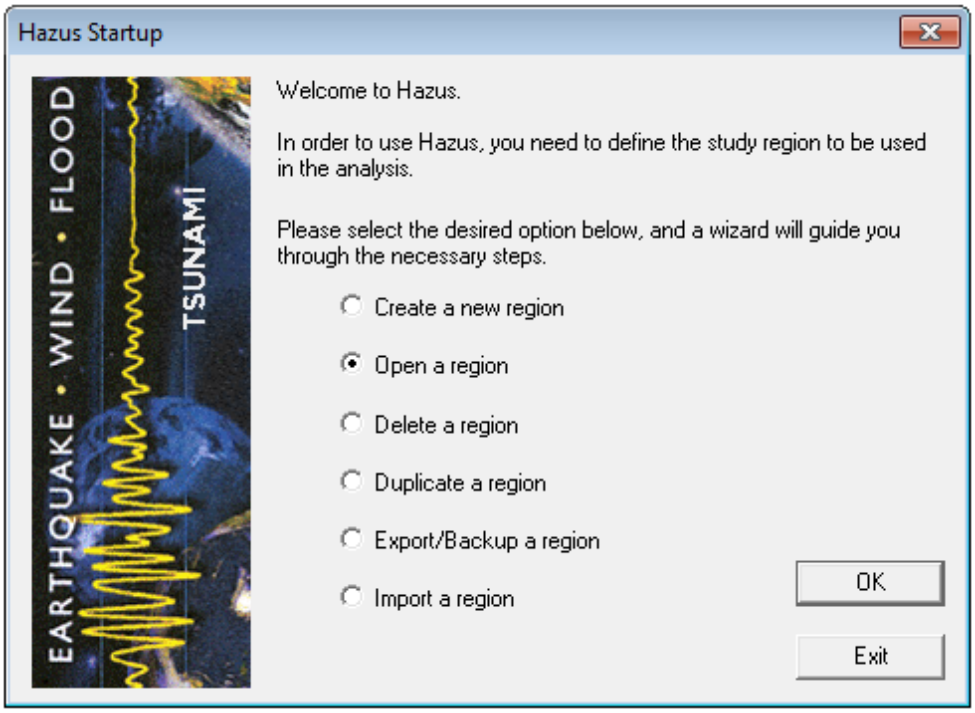


Figure 4-2: Open Region Wizard

In the **Select Region** window (Figure 4-3), select the desired Study Region. Click **Next,** which will open the **Completing the Region Review Wizard** (Figure 4-4). Here, the user can review the selected region and hazard. Select **Finish**. An ArcMap window showing the Study Region will open (Figure 4-5**)**.

Figure 4-3: Select the Region to Open

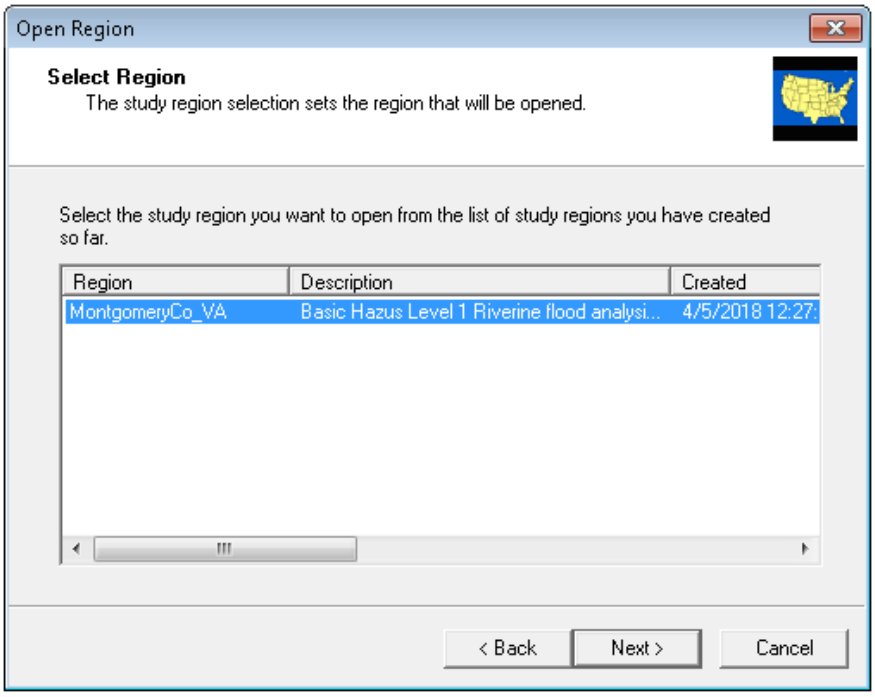
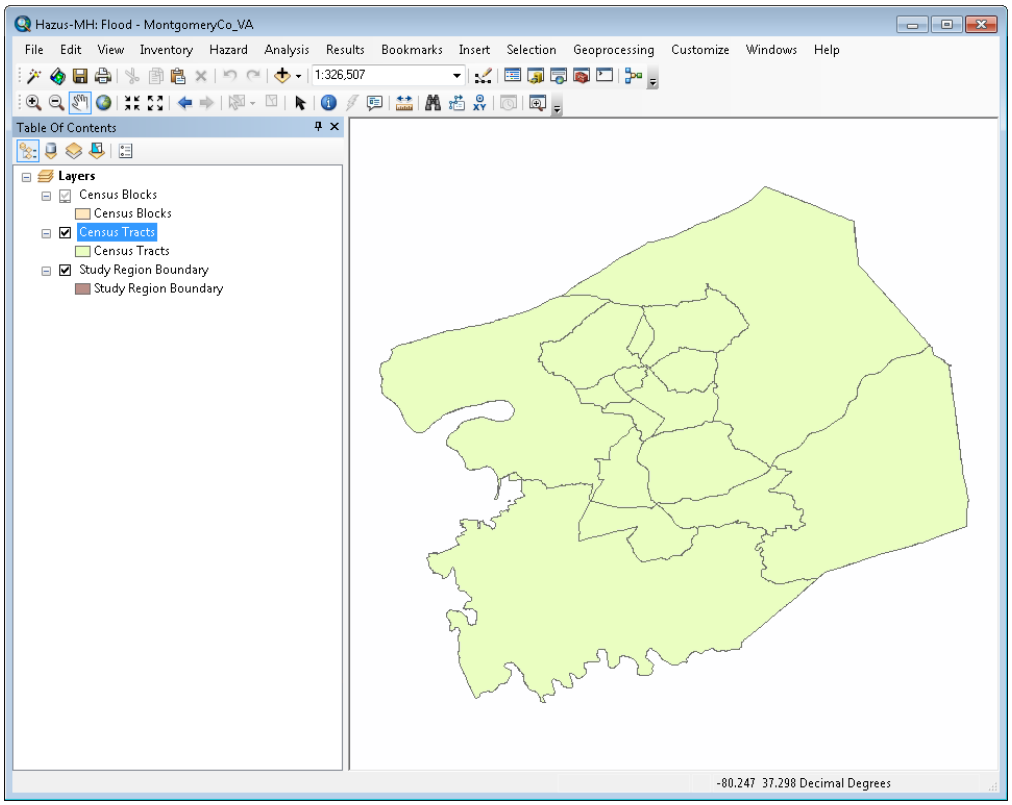


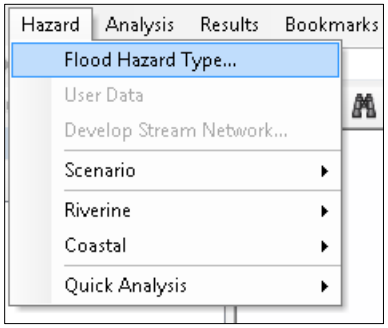
Figure 4-4: Confirm the Selected Region

Figure 4-5: Example – Flood Model in ArcMap



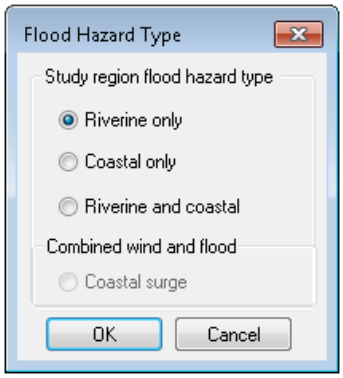
To choose a riverine flood hazard type, open the **Hazard** dropdown menu and select **Flood Hazard Type** (Figure 4-6).

Figure 4-6: Select Flood Hazard Type in Hazard Menu



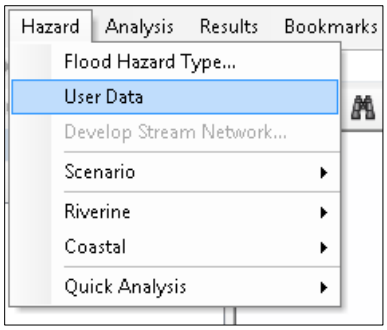
Selecting **Flood Hazard Type** will open the **Flood Hazard Type** window (Figure 4-7). Select **Riverine only**, and click **OK**.

Figure 4-7: Select Flood Hazard Type



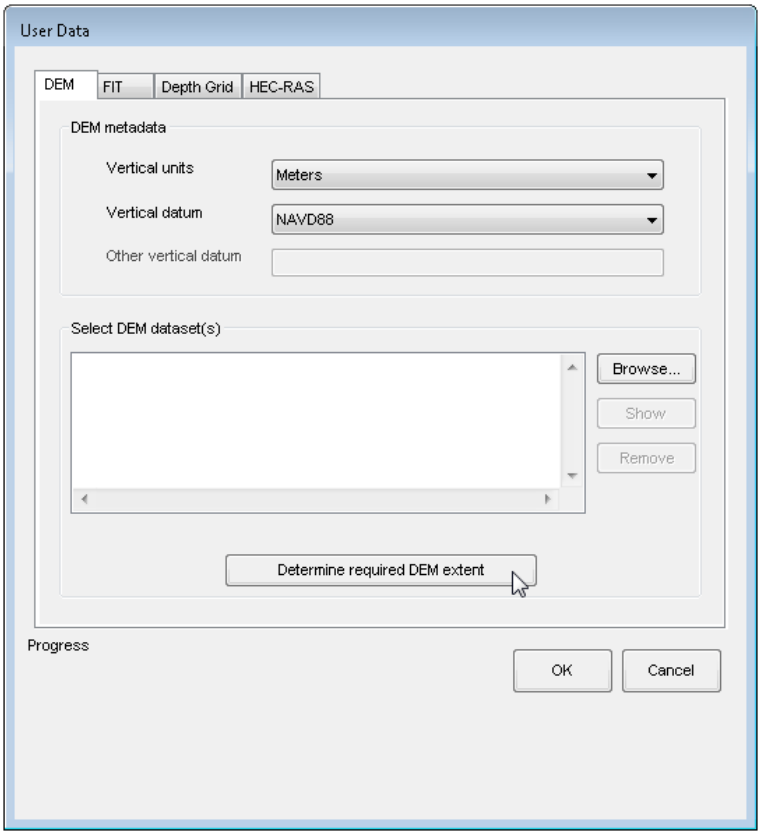
To obtain the required digital elevation data required for this analysis, open the **Hazard** dropdown menu and select **User Data** (Figure 4-8). Please note, it is recommended that users import user-defined flood hazard depth grids if available. The Hazus hydrology and hydraulic methodology here should only be used if user-defined data are not available. Please refer to *Hazus Flood Level 2 Standard Operating Procedure* published to the FEMA Library for more information.

Figure 4-8: Select User Data in Hazard Menu



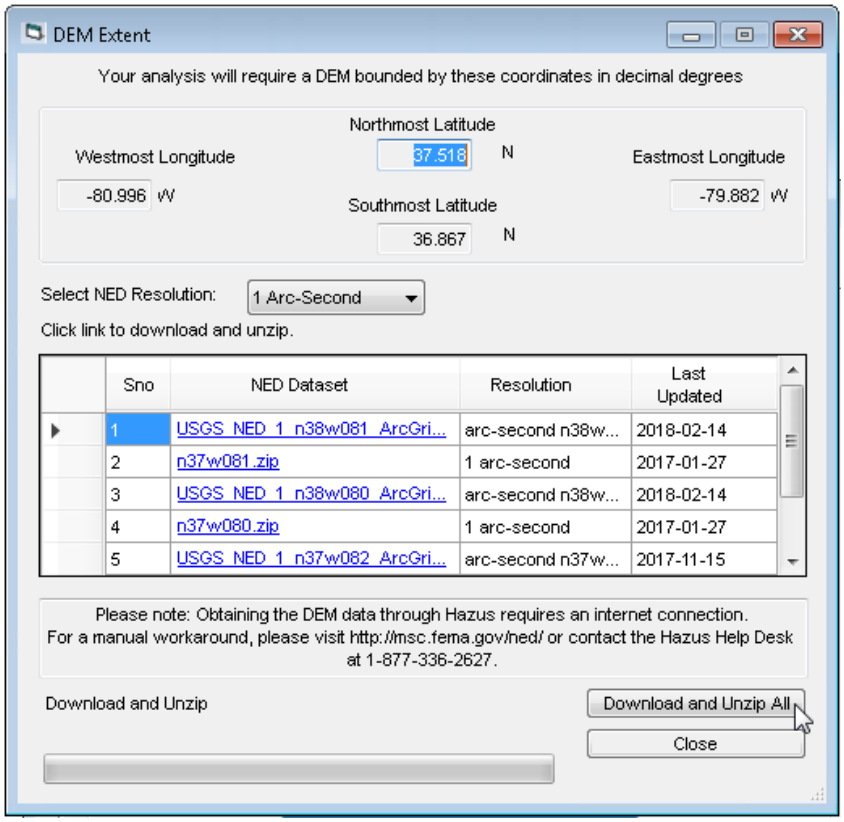
Selecting **User Data** will open the **User Data** window (Figure 4-9). Click **Determine required DEM extent**.

Figure 4-9: Select Determine Required DEM Extent



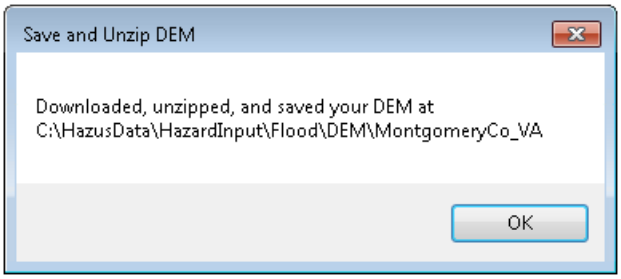
After a short pause, the **DEM Extent** window will appear (Figure 4-10). Click **Download and Unzip All** for Hazus to obtain all the required digital elevation model (DEM) files and save them within the Hazus Study Region folder.

Figure 4-10: Select Download and Unzip All



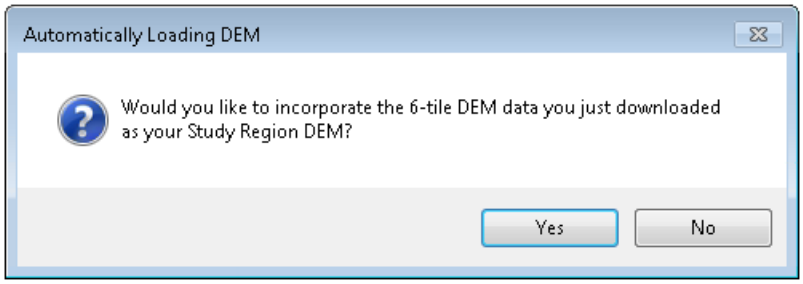
Hazus will take several minutes to download and unzip all of the DEM files. When the process has completed, a notification window will appear (Figure 4-11) to indicate the files have been downloaded, unzipped, and saved. Click **OK**.

Figure 4-11: DEM Downloaded, Unzipped, and Saved



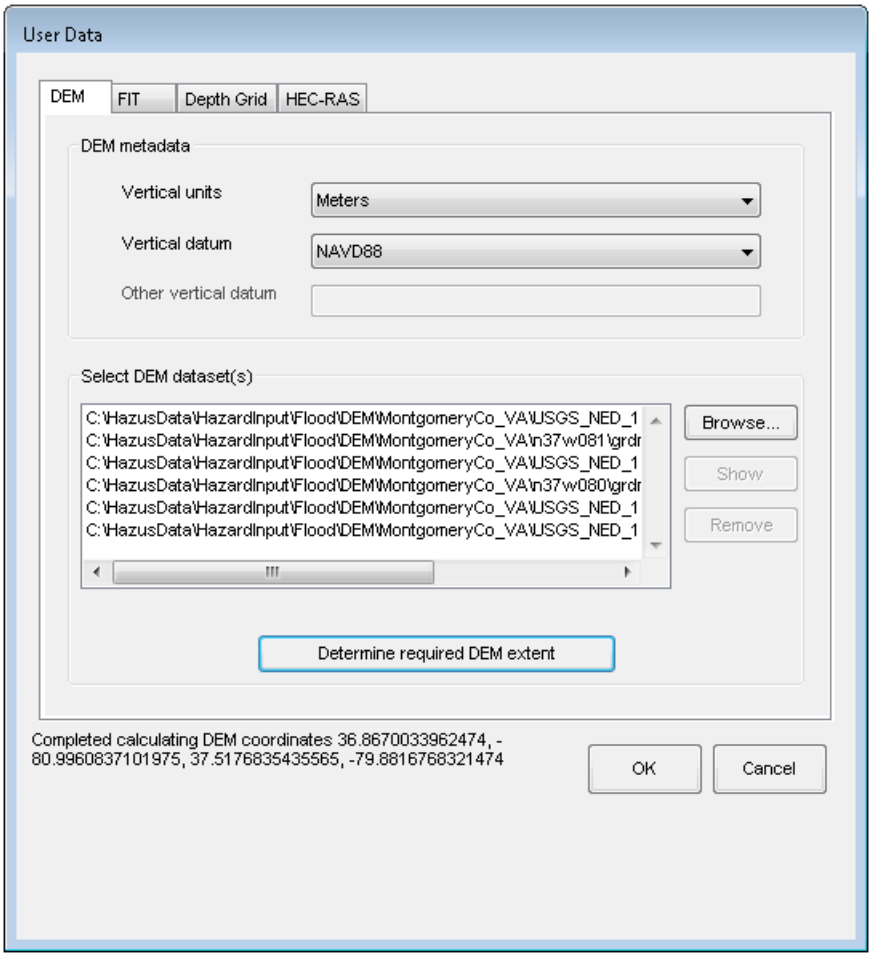
A popup window (Figure 4-12) will ask the user whether to automatically load the DEM data into the **User Data** window. Click **Yes**.

Figure 4-12: Automatically Load DEM



Hazus will load the file paths for all of the DEM files into the **User Data** window (Figure 4-13). Click **OK** to complete importing the DEM files. Click **Yes** (not shown) on the next popup window to proceed with DEM analysis.

Figure 4-13: Import DEM Files into Hazus



A progress bar (Figure 4-14) will appear as Hazus imports and merges all the individual files into a single DEM for the Study Region. This may take several minutes depending on the size of the Study Region. A notification (Figure 4-15) will appear once the DEM import is completed. Click **OK**.

Figure 4-14: DEM Import Progress

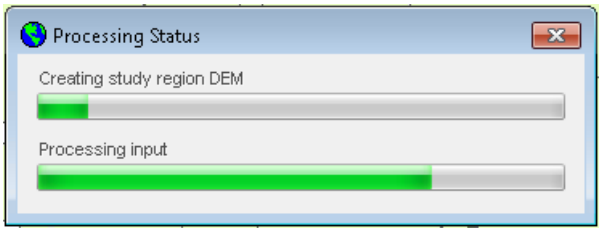
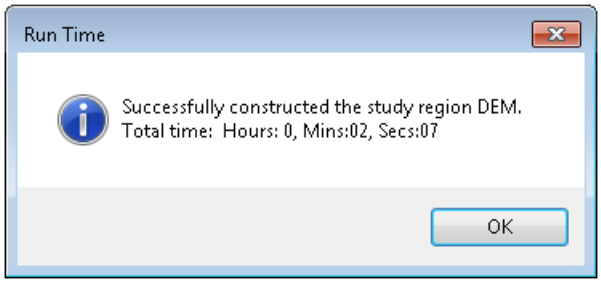
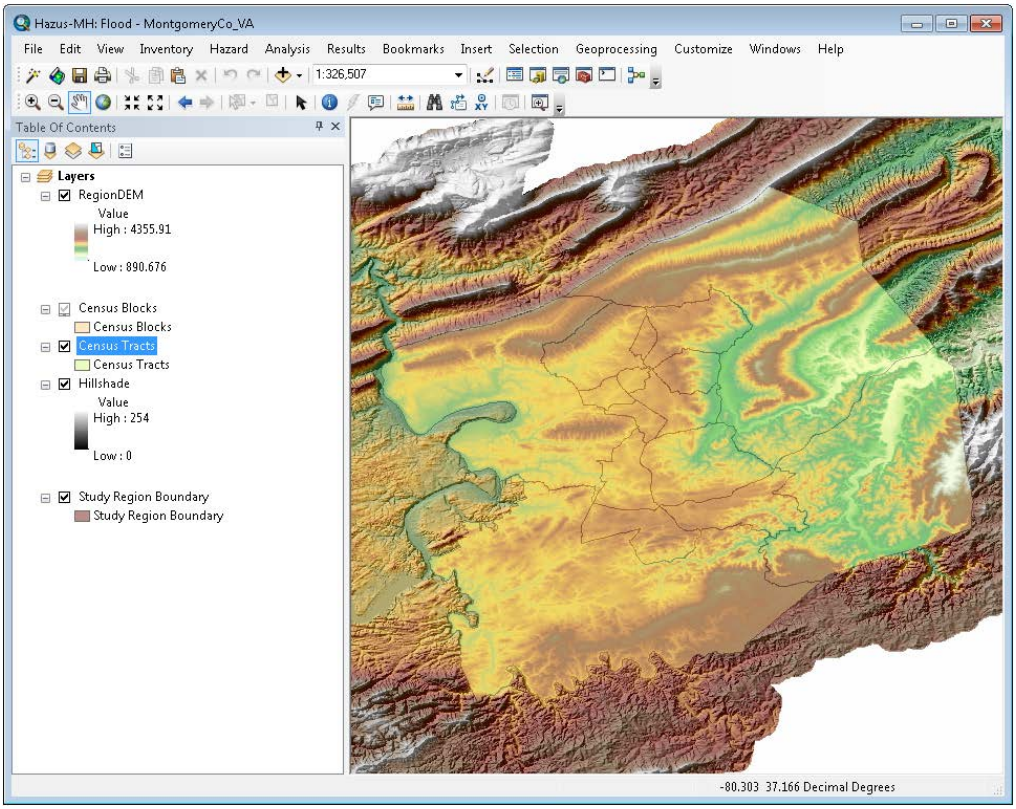


Figure 4-15: DEM Import Completed



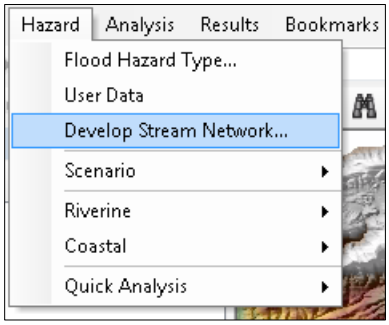
The Hazus Flood Model mapping should look similar to Figure 4-16 after the DEM import.

Figure 4-16: Example – Flood Model after DEM Import



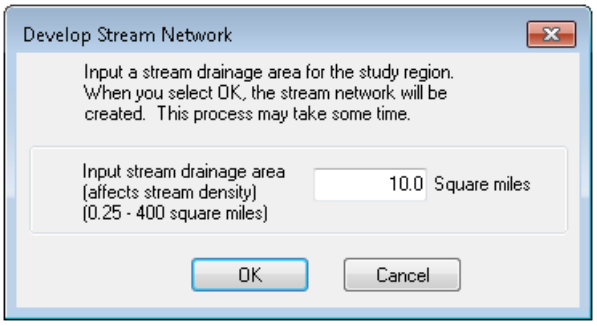
To create the stream network, open the **Hazard** dropdown menu and select **Develop Stream Network** (Figure 4-17).

Figure 4-17: Select Develop Stream Network in Hazard Menu



The **Develop Stream Network** window (Figure 4-18) will appear. Use the default value of 10.0 square miles that appears in the drainage area field and click **OK**. Click **Yes** (not shown) on the next popup window to proceed with developing the stream network.

Figure 4-18: Enter Drainage Area for Develop Stream Network



A progress bar (Figure 4-19) will appear as Hazus performs the GIS analysis to develop the stream network. This may take several minutes to an hour depending on the size of the Study Region. A notification (Figure 4-20) will appear once the stream network has been completed. Click **OK**.

Figure 4-19: Develop Stream Network Progress

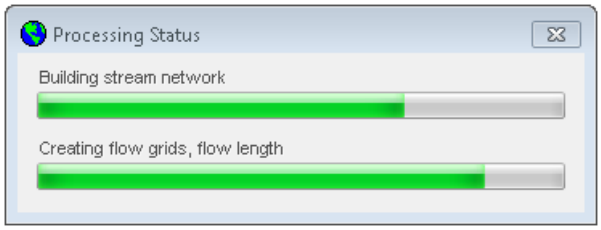
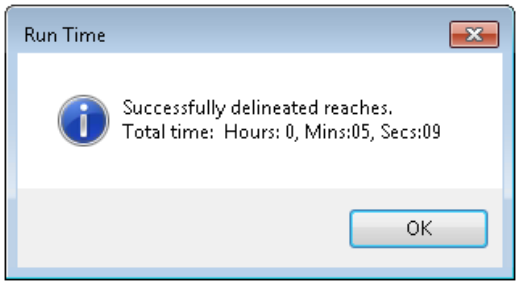
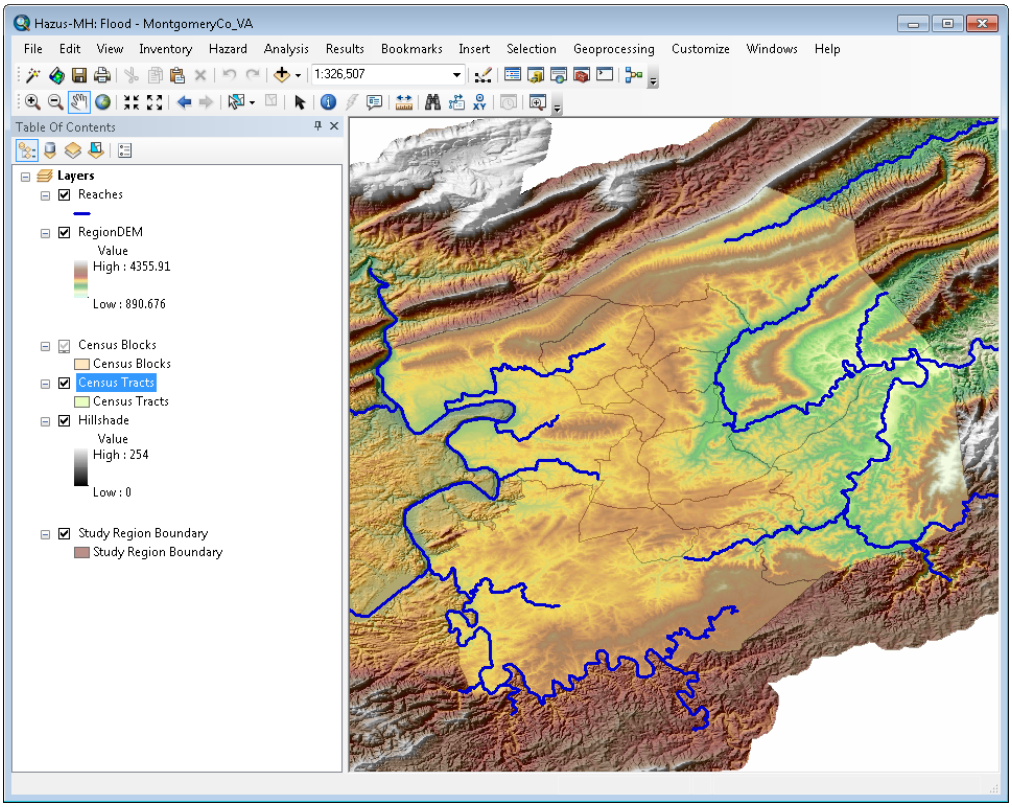


Figure 4-20: Develop Stream Network Completed



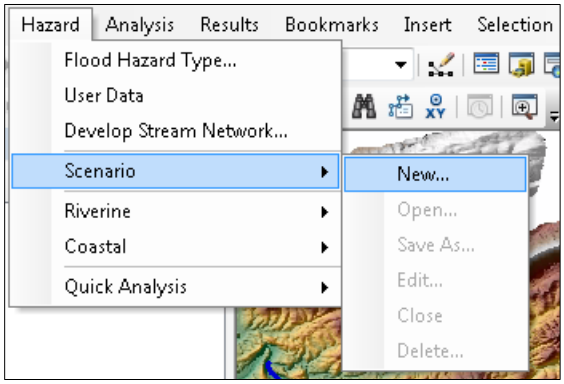
The Hazus Flood Model mapping should look similar to Figure 4-21 after developing the stream network.

Figure 4-21: Example – Flood Model after Developing Stream Network



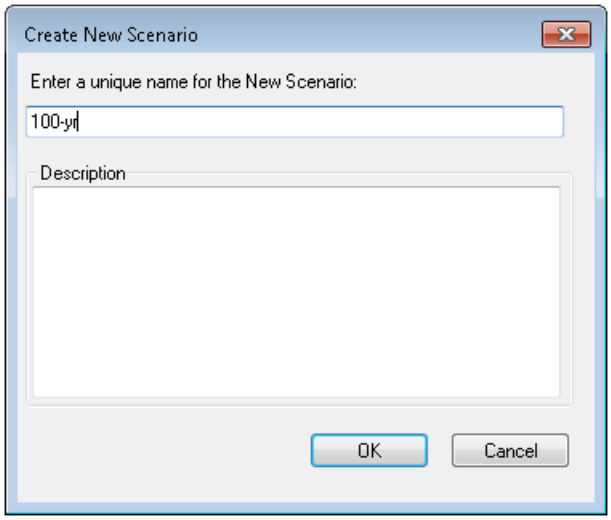
To create a scenario within the Flood Model, open the **Hazard** dropdown menu and select **Scenario** and **New** (Figure 4-22).

Figure 4-22: Select Scenario and New in Hazard Menu



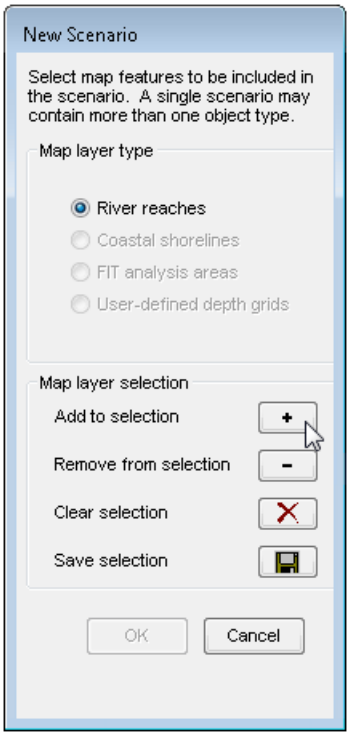
The **Create New Scenario** window (Figure 4-23) will appear. Enter a unique name for the scenario and a brief description. Click **OK**.

Figure 4-23: Provide Name for New Scenario



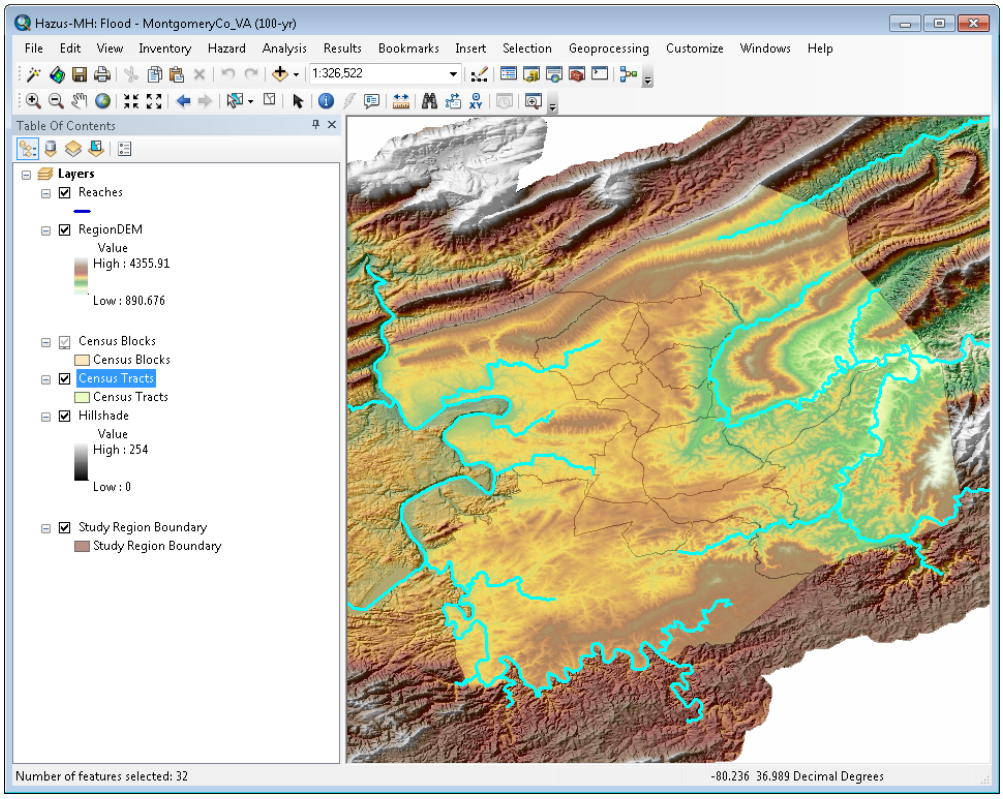
The **New Scenario** window (Figure 4-24) will appear. To select the streams to add to the scenario from the Flood Model mapping, click the **+** button to the right of **Add to selection**. This will activate the screen cursor on the mapping screen in ArcMap, which allows the user to select all the streams in the region.

Figure 4-24: Select Add to Selection for River Reaches



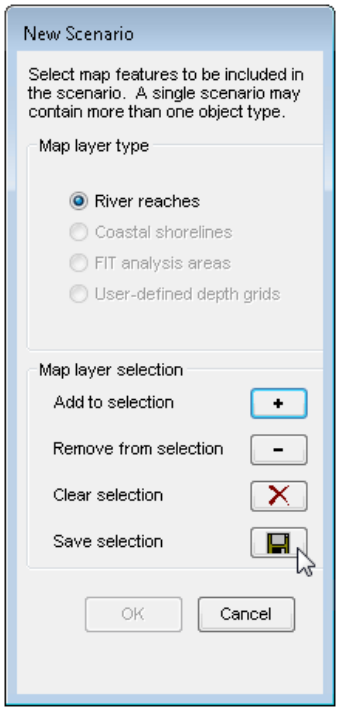
Once the streams have been selected, the Flood Model will show the streams in a different color as shown in Figure 4-25.

Figure 4-25: Example – Flood Model after Stream Selection



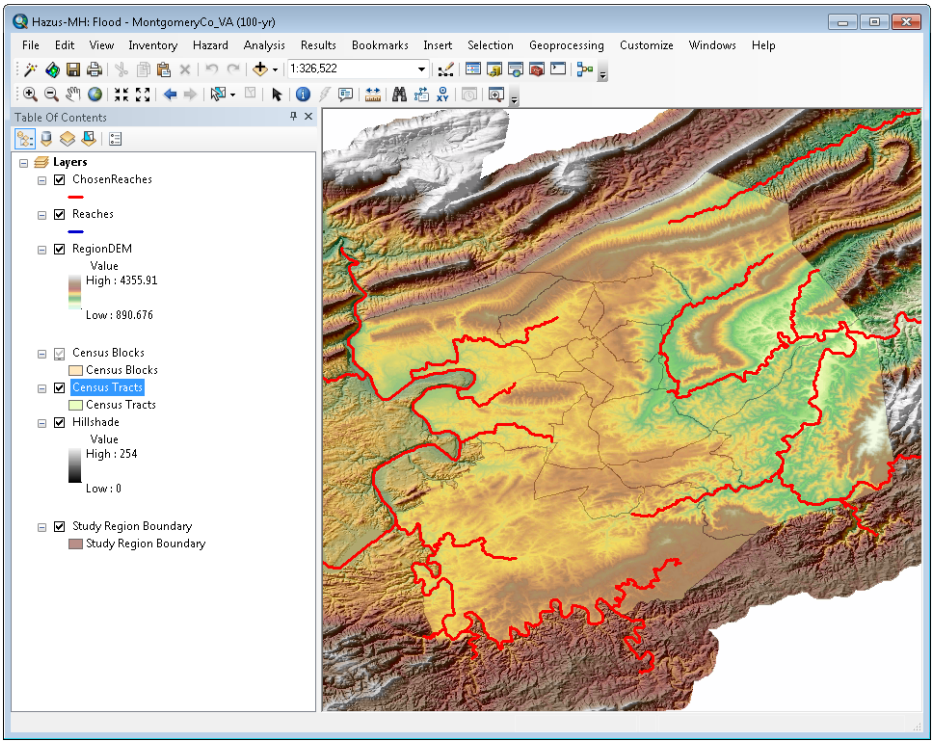
To complete the stream selection, go back to the **New Scenario** window and click on the button with the disk graphic to the right of **Save selection** (Figure 4-26). The **OK** button will become active. Click **OK** to complete the stream selection.

Figure 4-26: Select Save Selection to Finalize Selected River Reaches



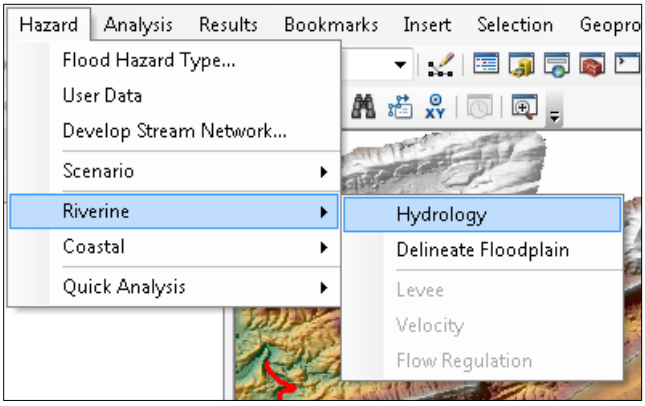
If the stream selection was performed correctly, the Flood Model should look similar to Figure 4-27. All selected streams are saved to a new data layer called **Chosen Reaches** and are shown in red.

Figure 4-27: Example – Flood Model after Stream Reaches Chosen for a Scenario



To conduct the hydrologic analysis, open the **Hazard** dropdown menu and select **Hydrology** (Figure 4-28).

Figure 4-28: Select Riverine and Hydrology in Hazard Menu



A notification window (Figure 4-29) will warn the user that raster processing cannot be canceled. Click **Yes**.

A progress bar (Figure 4-30) will appear as Hazus performs the hydrologic analysis. This may take several minutes to several hours depending on the size of the Study Region and the number of selected streams. A notification (Figure 4-31) will appear once the hydrologic analysis has been completed. Click **OK**.

Figure 4-29: Select Yes to Start Hydrologic Analysis

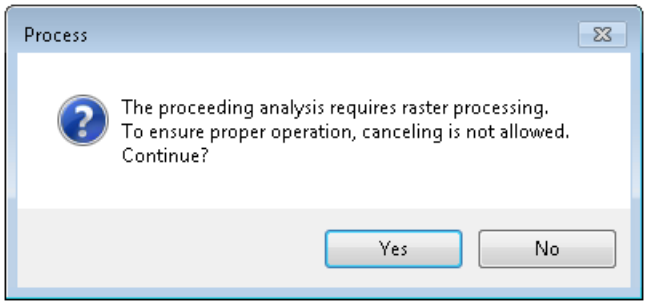


Figure 4-30: Hydrologic Analysis Progress

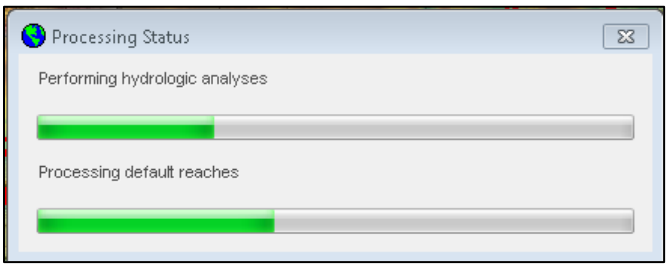
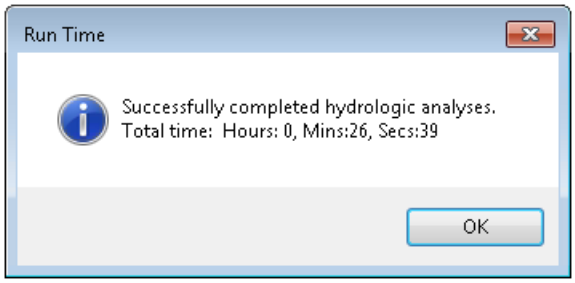
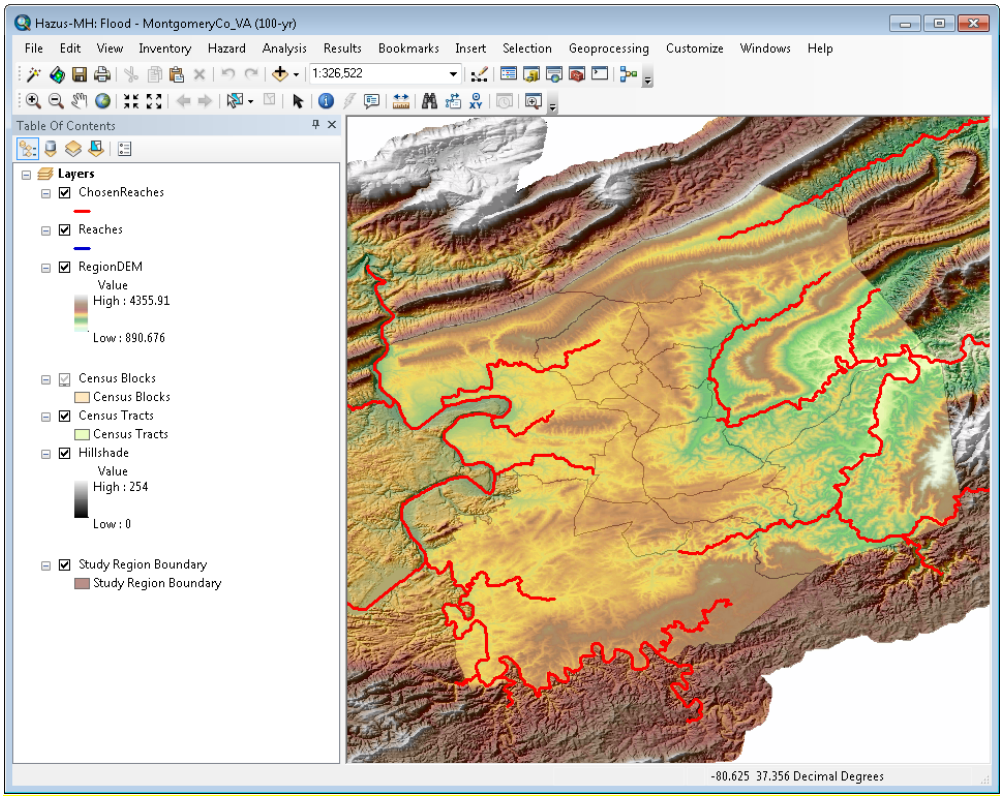


Figure 4-31: Hydrologic Analysis Completed



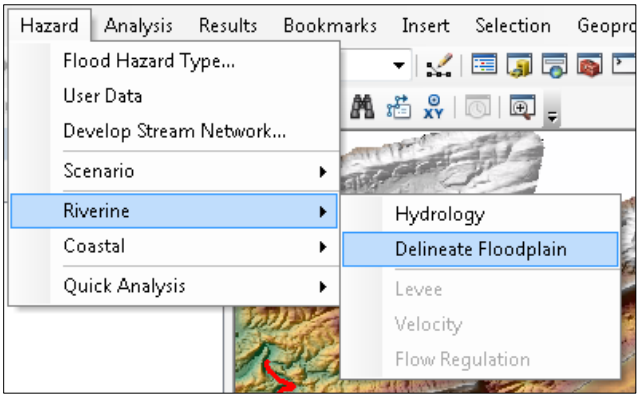
If the hydrologic analysis was performed correctly, the Flood Model should look similar to Figure 4-32.

Figure 4-32: Example – Flood Model after Hydrologic Analysis



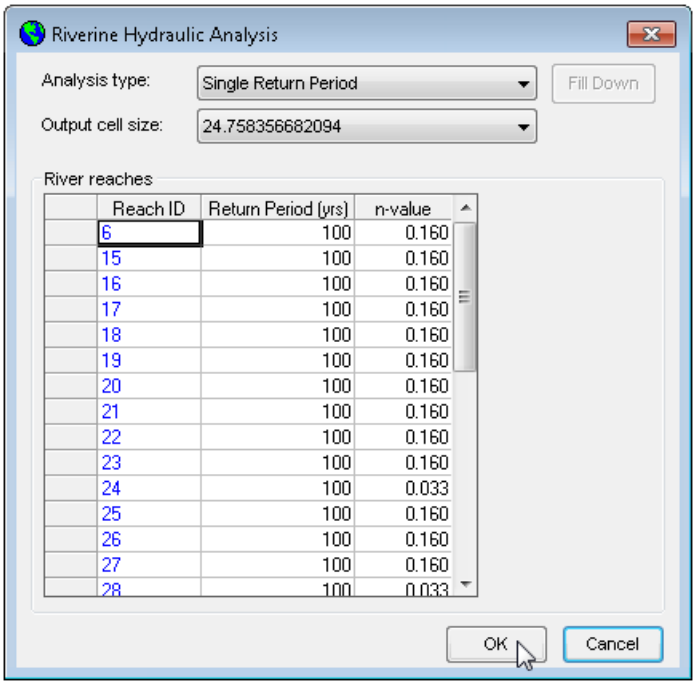
To conduct the floodplain analysis, open the **Hazard** dropdown menu and select **Delineate Floodplain** (Figure 4-33).

Figure 4-33: Select Riverine and Delineate Floodplain in Hazard Menu



The **Riverine Hydraulic Analysis** window (Figure 4-34) will open. Select **Single Return Period** for **Analysis type**. Keep the default **Output cell size**. Finally, for each stream keep the default return period of 100 years and the default Manning's roughness coefficient n-value shown in the third column of the table. Click **OK**.

Figure 4-34: Delineate Floodplain for a Single Return Period



A progress bar (Figure 4-35) will appear as Hazus performs the hydraulic analysis needed to delineate the floodplain for each selected stream. This may take several minutes to several hours depending on the size of the Study Region and the number of selected streams. A notification (Figure 4-36) will appear once the floodplain analysis has been completed. Click **OK**.

Figure 4-35: Delineate Floodplain Progress

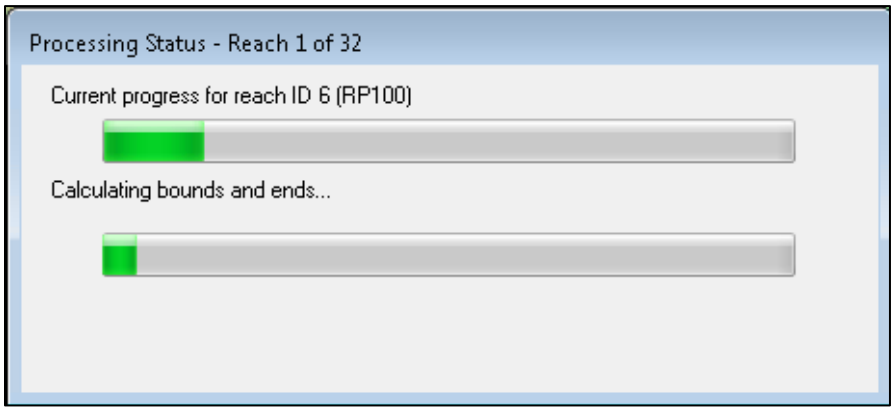
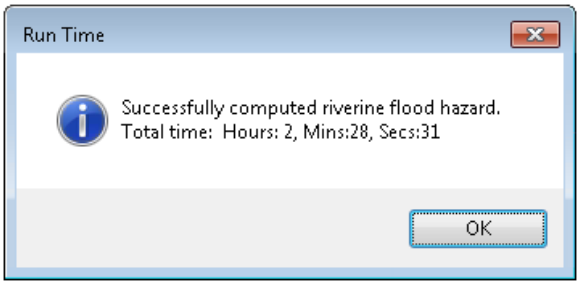
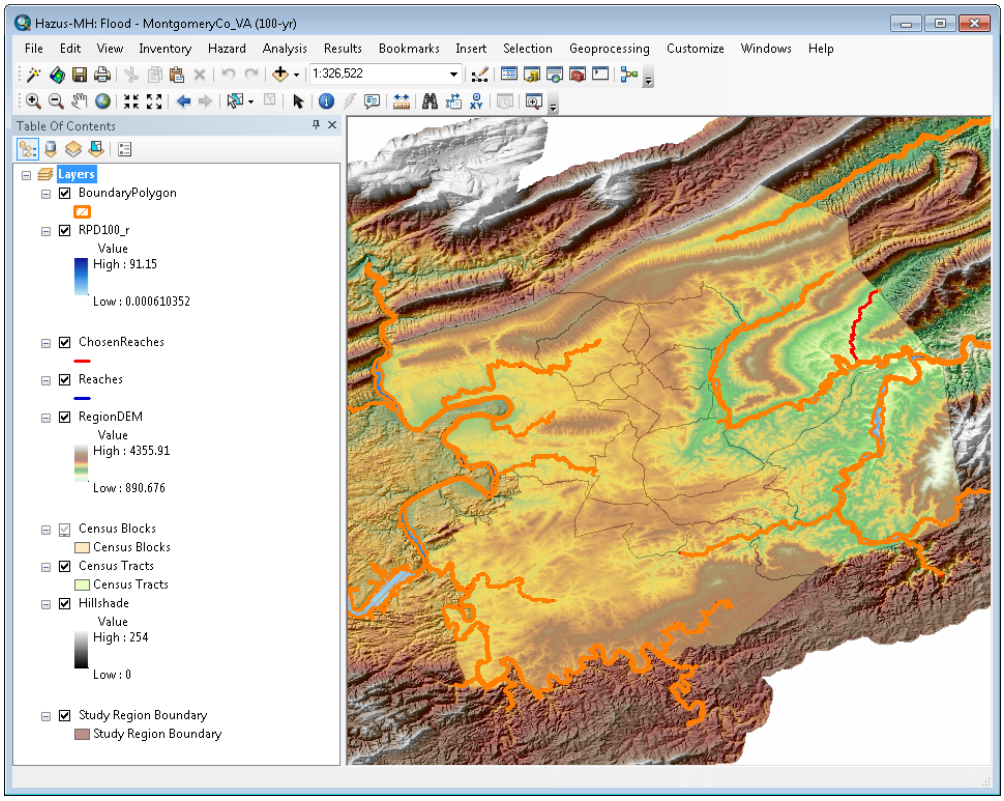


Figure 4-36: Delineate Floodplain Completed



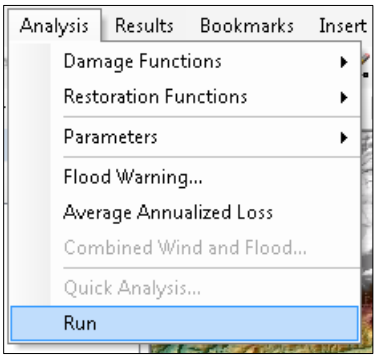
If the floodplain analysis was performed correctly, the Flood Model should look similar to Figure 4-37.

Figure 4-37: Example – Flood Model after Delineate Floodplain



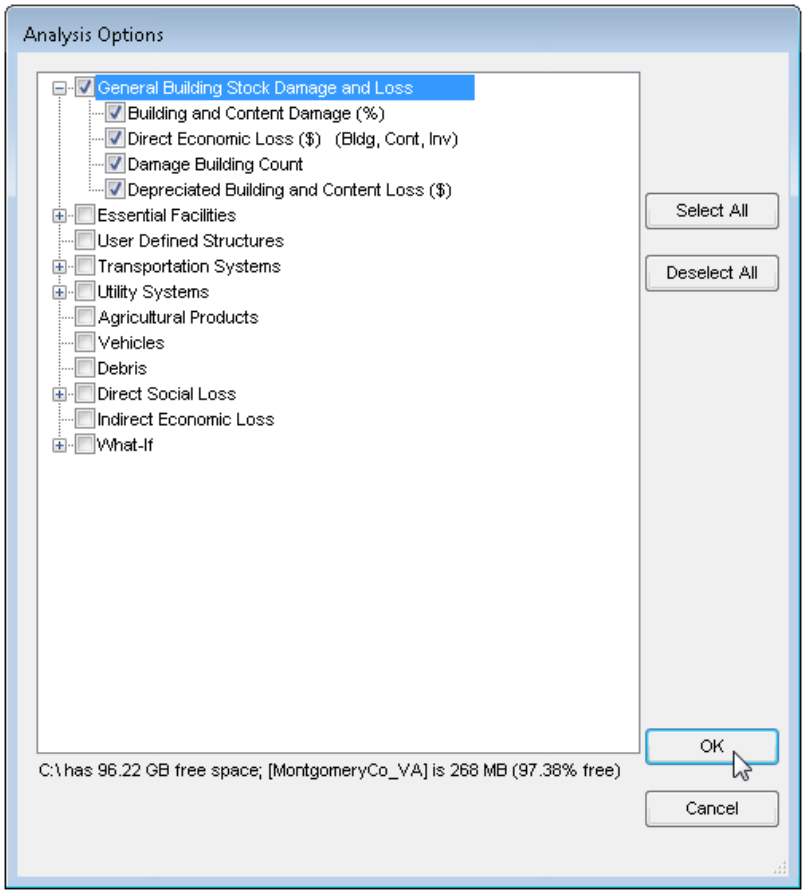
Begin computing losses within the Study Region's newly delineated floodplains by opening the **Analysis** dropdown menu and selecting **Run** (Figure 4-38).

Figure 4-38: Select Run in Analysis Menu



The **Analysis Options** window (Figure 4-39) will open. Click the **+** button to the left of **General Building Stock Damage and Loss** to expand and view the loss category. Next, click the small open box to the left of **General Building Stock Damage and Loss** so that all sub categories are also selected. Click **OK**.

Figure 4-39: Select General Building Stock Damage and Loss from Analysis Options



A progress bar (Figure 4-40) will appear as Hazus calculates flood losses. This may take several minutes to several hours depending on the size of the Study Region. A notification (Figure 4-41) will appear once floodplain losses have been completed. Click **OK**.

Figure 4-40: Flood Losses Progress

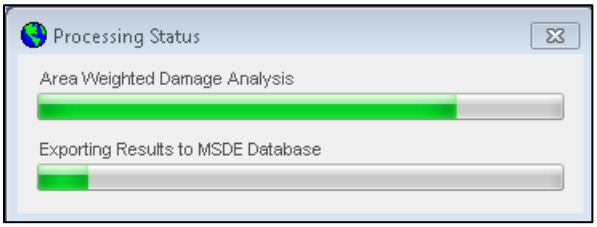
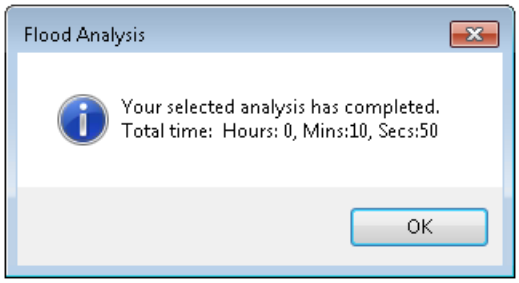


Figure 4-41: Flood Losses Completed

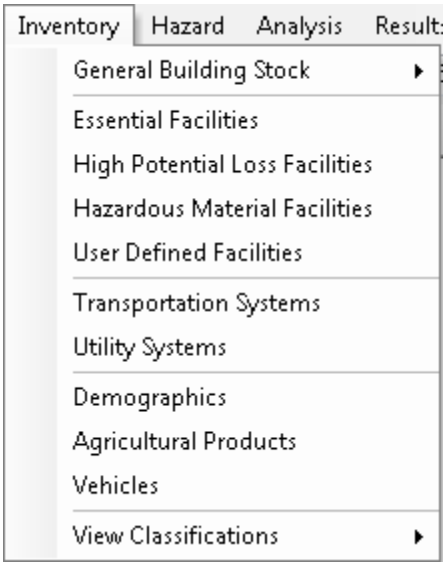


At this point, the user will have successfully created a Study Region, delineated streams and floodplains, and calculated losses. For more information on displaying, understanding, and exporting loss results, see Chapter 8.

5 Model Menu: Inventory

The **Inventory** menu, shown in Figure 5-1, has inventory types and subtypes that allow the estimation of the amount of exposure and potential damage in the Study Region. Inventory data include basic information on population, buildings, and facilities obtained from the United States Census and other national sources. These data can be supplemented with additional user supplied datasets. The screenshots in this chapter show all of the options for the **Inventory** menu.

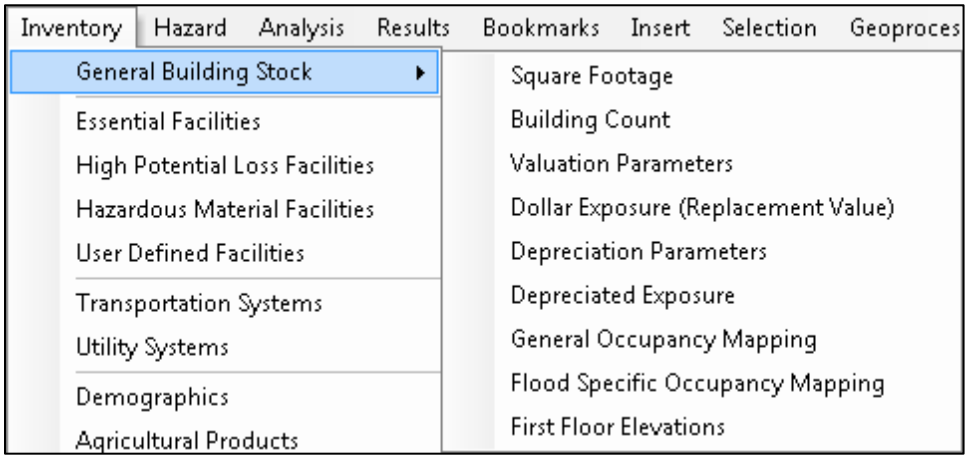
Figure 5-1: Inventory Menu



5.1 General Building Stock

The first type of inventory is **General Building Stock**. The subtypes are Square Footage, Building Count, Valuation Parameters, Dollar Exposure, Depreciation Parameters, Depreciated Exposure, General Occupancy Mapping, Flood Specific Occupancy Mapping, and First Floor Elevations, as shown in Figure 5-2.

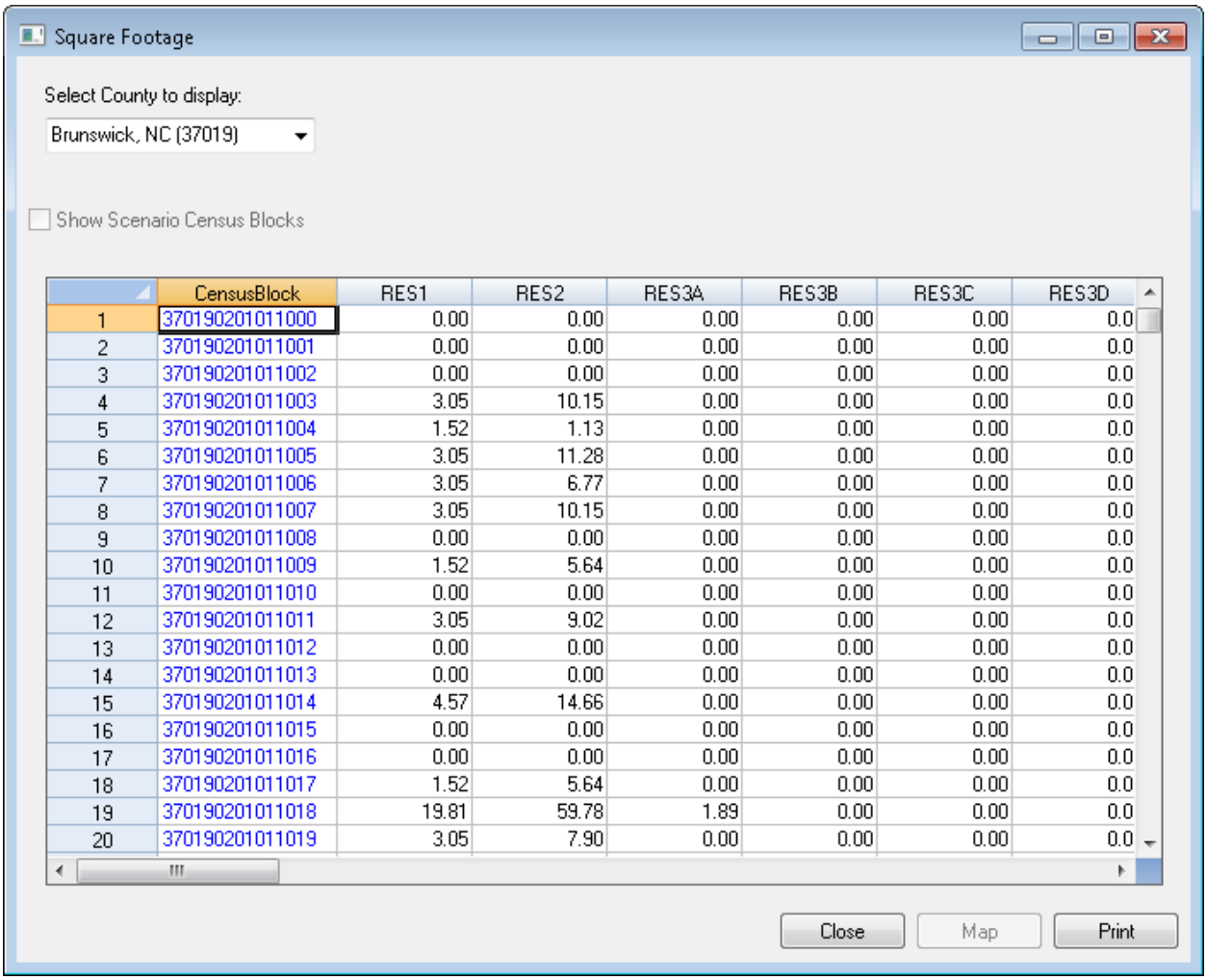
Figure 5-2: Inventory / General Building Stock Menu



5.1.1 Square Footage

Square Footage, opened through the menu shown in Figure 5-2, allows the user to view the type of square footage distribution per the census block, as shown in Figure 5-3.

Figure 5-3: Square Footage Table

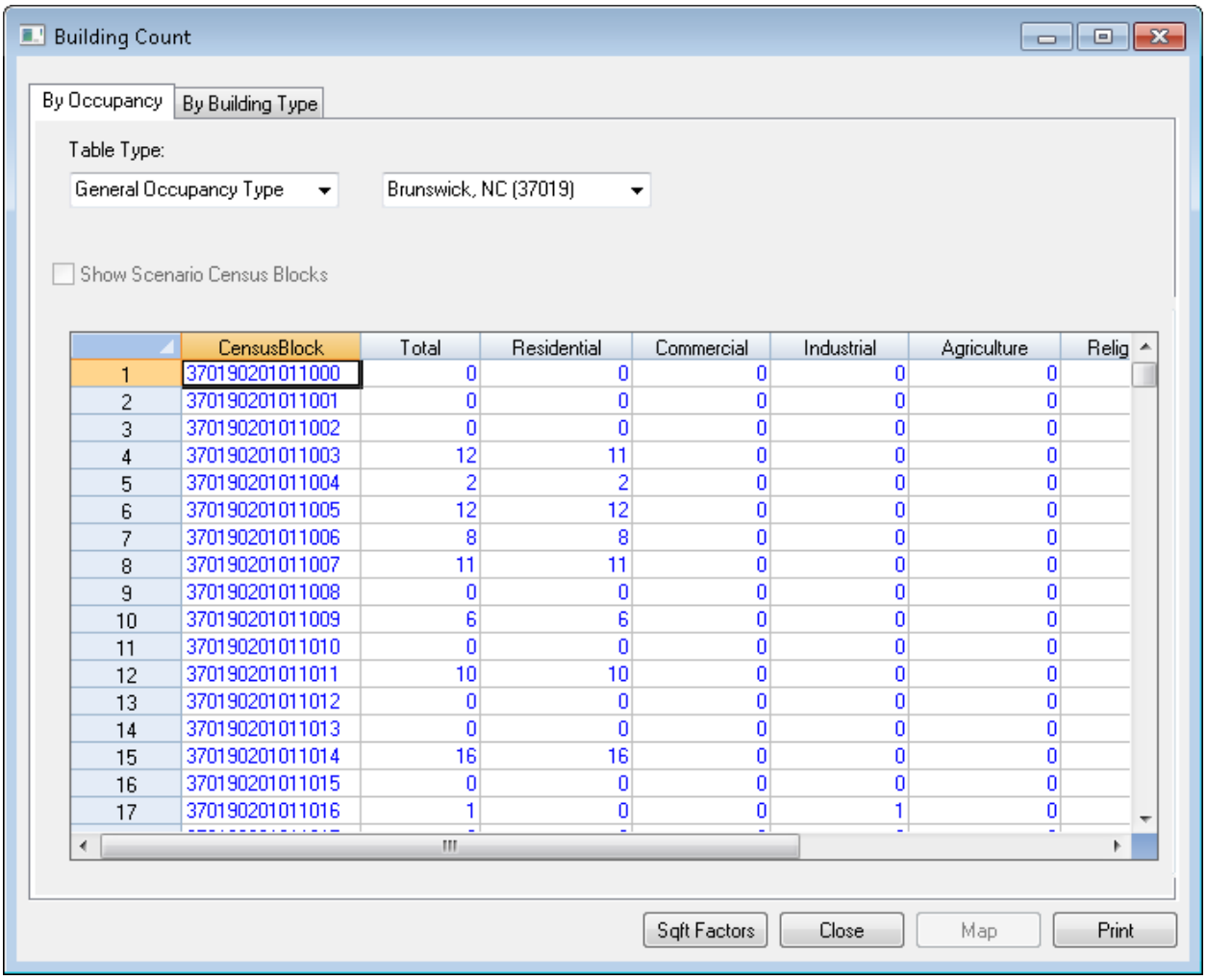


	CensusBlock	RES1	RES2	RES3A	RES3B	RES3C	RES3D
1	370190201011000	0.00	0.00	0.00	0.00	0.00	0.0
2	370190201011001	0.00	0.00	0.00	0.00	0.00	0.0
3	370190201011002	0.00	0.00	0.00	0.00	0.00	0.0
4	370190201011003	3.05	10.15	0.00	0.00	0.00	0.0
5	370190201011004	1.52	1.13	0.00	0.00	0.00	0.0
6	370190201011005	3.05	11.28	0.00	0.00	0.00	0.0
7	370190201011006	3.05	6.77	0.00	0.00	0.00	0.0
8	370190201011007	3.05	10.15	0.00	0.00	0.00	0.0
9	370190201011008	0.00	0.00	0.00	0.00	0.00	0.0
10	370190201011009	1.52	5.64	0.00	0.00	0.00	0.0
11	370190201011010	0.00	0.00	0.00	0.00	0.00	0.0
12	370190201011011	3.05	9.02	0.00	0.00	0.00	0.0
13	370190201011012	0.00	0.00	0.00	0.00	0.00	0.0
14	370190201011013	0.00	0.00	0.00	0.00	0.00	0.0
15	370190201011014	4.57	14.66	0.00	0.00	0.00	0.0
16	370190201011015	0.00	0.00	0.00	0.00	0.00	0.0
17	370190201011016	0.00	0.00	0.00	0.00	0.00	0.0
18	370190201011017	1.52	5.64	0.00	0.00	0.00	0.0
19	370190201011018	19.81	59.78	1.89	0.00	0.00	0.0
20	370190201011019	3.05	7.90	0.00	0.00	0.00	0.0

5.1.2 Building Count

Building Count allows the user to review the building count per census block **By Occupancy** and **By Building Type** for specific and general occupancies, as shown in Figure 5-4. The user can view and modify the building count values by only specific occupancy for each census block.

Figure 5-4: Building Count (by Occupancy) Table



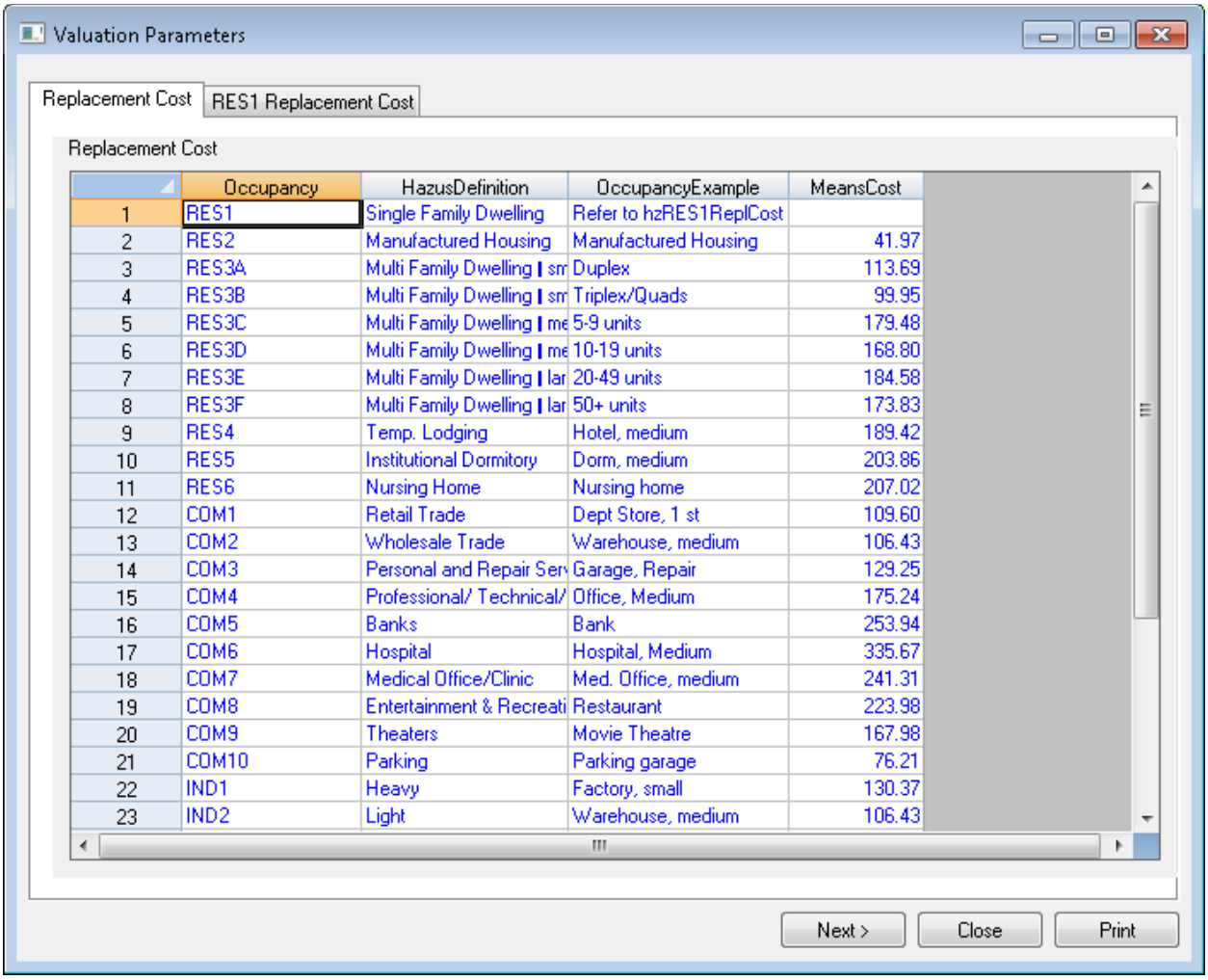
	CensusBlock	Total	Residential	Commercial	Industrial	Agriculture	Relig
1	370190201011000	0	0	0	0	0	
2	370190201011001	0	0	0	0	0	
3	370190201011002	0	0	0	0	0	
4	370190201011003	12	11	0	0	0	
5	370190201011004	2	2	0	0	0	
6	370190201011005	12	12	0	0	0	
7	370190201011006	8	8	0	0	0	
8	370190201011007	11	11	0	0	0	
9	370190201011008	0	0	0	0	0	
10	370190201011009	6	6	0	0	0	
11	370190201011010	0	0	0	0	0	
12	370190201011011	10	10	0	0	0	
13	370190201011012	0	0	0	0	0	
14	370190201011013	0	0	0	0	0	
15	370190201011014	16	16	0	0	0	
16	370190201011015	0	0	0	0	0	
17	370190201011016	1	0	0	1	0	

5.1.3 Valuation Parameters

Valuation Parameters allow the user to review the replacement costs for each occupancy type, as shown in Figure 5-5. Clicking the **Next** button on each window will take the user through the following information windows:

1. Replacement Cost (based on a specific year)
2. Location Factors
3. Single Family (RES1) Garage Distributions by Census Block
4. Single Family (RES1) Garage Replacement Cost
5. Single Family (RES1) Basement Distribution by Census Block
6. Height Distribution (Number of Stories) by Census Block

Figure 5-5: Valuation Parameters Table

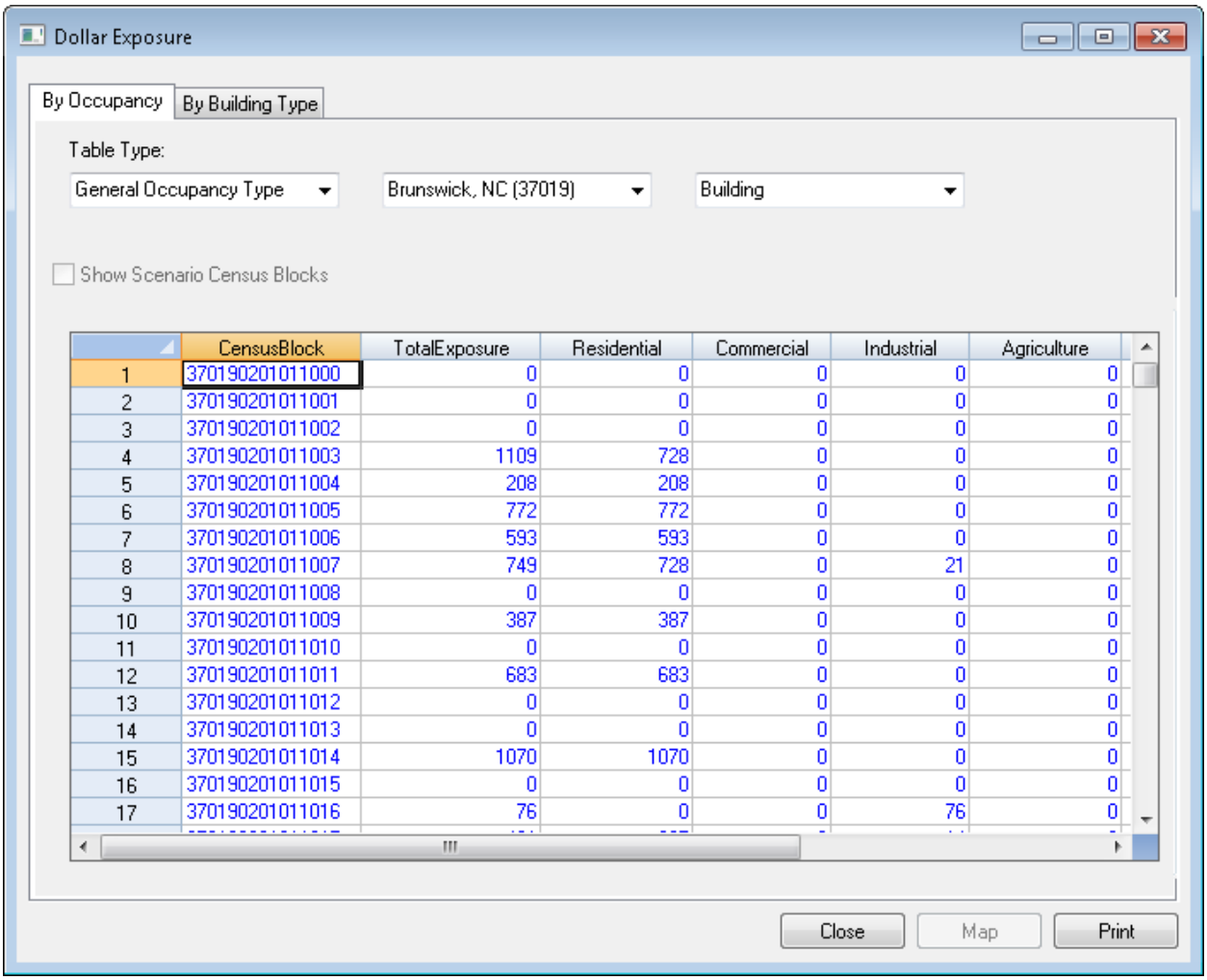


	Occupancy	HazusDefinition	OccupancyExample	MeansCost
1	RES1	Single Family Dwelling	Refer to hzRES1ReplCost	
2	RES2	Manufactured Housing	Manufactured Housing	41.97
3	RES3A	Multi Family Dwelling | sm	Duplex	113.69
4	RES3B	Multi Family Dwelling | sm	Triplex/Quads	99.95
5	RES3C	Multi Family Dwelling | me	5-9 units	179.48
6	RES3D	Multi Family Dwelling | me	10-19 units	168.80
7	RES3E	Multi Family Dwelling | lar	20-49 units	184.58
8	RES3F	Multi Family Dwelling | lar	50+ units	173.83
9	RES4	Temp. Lodging	Hotel, medium	189.42
10	RES5	Institutional Dormitory	Dorm, medium	203.86
11	RES6	Nursing Home	Nursing home	207.02
12	COM1	Retail Trade	Dept Store, 1 st	109.60
13	COM2	Wholesale Trade	Warehouse, medium	106.43
14	COM3	Personal and Repair Serv	Garage, Repair	129.25
15	COM4	Professional/ Technical/	Office, Medium	175.24
16	COM5	Banks	Bank	253.94
17	COM6	Hospital	Hospital, Medium	335.67
18	COM7	Medical Office/Clinic	Med. Office, medium	241.31
19	COM8	Entertainment & Recreati	Restaurant	223.98
20	COM9	Theaters	Movie Theatre	167.98
21	COM10	Parking	Parking garage	76.21
22	IND1	Heavy	Factory, small	130.37
23	IND2	Light	Warehouse, medium	106.43

5.1.4 Dollar Exposure (Replacement Value):

Dollar Exposure (Figure 5-6) allows the user to review the exposure per census block **By Occupancy** and **By Building Type**. The user can view and modify the exposure values by only specific occupancy for each census block.

Figure 5-6: Dollar Exposure Table

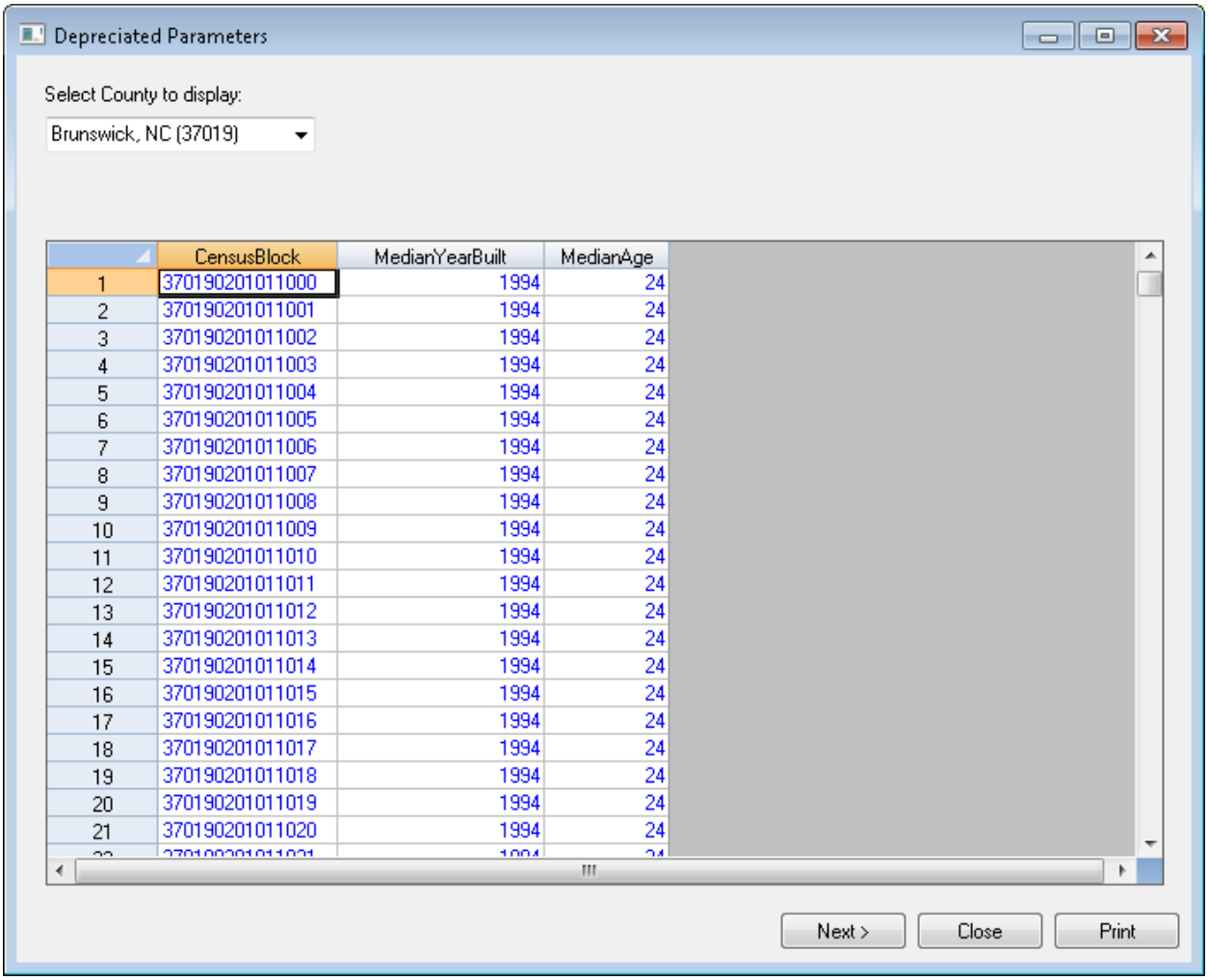


	CensusBlock	TotalExposure	Residential	Commercial	Industrial	Agriculture
1	370190201011000	0	0	0	0	0
2	370190201011001	0	0	0	0	0
3	370190201011002	0	0	0	0	0
4	370190201011003	1109	728	0	0	0
5	370190201011004	208	208	0	0	0
6	370190201011005	772	772	0	0	0
7	370190201011006	593	593	0	0	0
8	370190201011007	749	728	0	21	0
9	370190201011008	0	0	0	0	0
10	370190201011009	387	387	0	0	0
11	370190201011010	0	0	0	0	0
12	370190201011011	683	683	0	0	0
13	370190201011012	0	0	0	0	0
14	370190201011013	0	0	0	0	0
15	370190201011014	1070	1070	0	0	0
16	370190201011015	0	0	0	0	0
17	370190201011016	76	0	0	76	0

5.1.5 Depreciation Parameters

Depreciation Parameters (Figure 5-7) allow the user to review the median year built and median age of buildings in each census block.

Figure 5-7: Depreciation Parameters Table

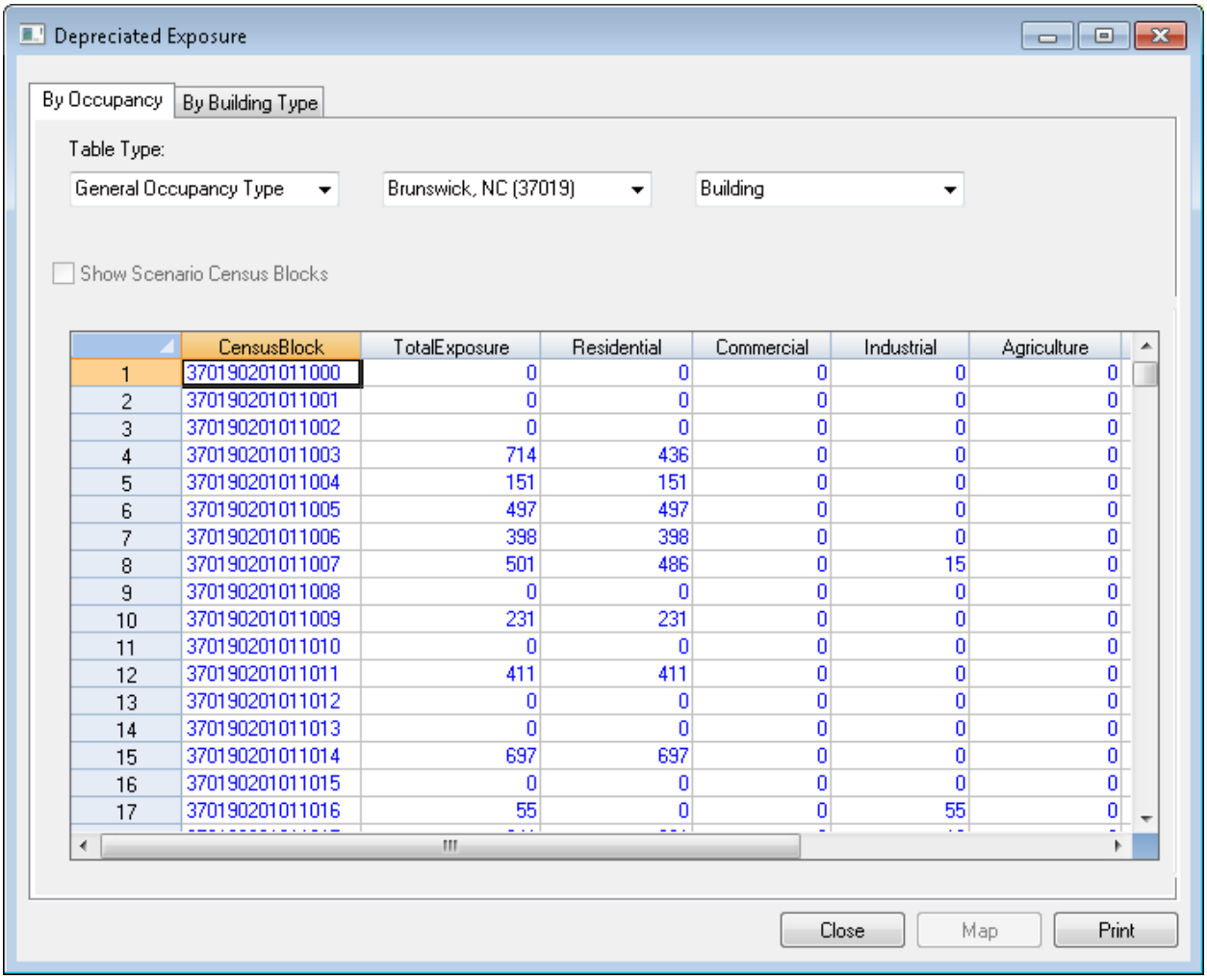


	CensusBlock	MedianYearBuilt	MedianAge
1	370190201011000	1994	24
2	370190201011001	1994	24
3	370190201011002	1994	24
4	370190201011003	1994	24
5	370190201011004	1994	24
6	370190201011005	1994	24
7	370190201011006	1994	24
8	370190201011007	1994	24
9	370190201011008	1994	24
10	370190201011009	1994	24
11	370190201011010	1994	24
12	370190201011011	1994	24
13	370190201011012	1994	24
14	370190201011013	1994	24
15	370190201011014	1994	24
16	370190201011015	1994	24
17	370190201011016	1994	24
18	370190201011017	1994	24
19	370190201011018	1994	24
20	370190201011019	1994	24
21	370190201011020	1994	24

5.1.6 Depreciated Exposure

Depreciated Exposure (Figure 5-8) allows the user to review the depreciated exposure **By Occupancy** or **By Building Type**. This data is calculated based on the median building age and a depreciation curve. The user can view and modify the building depreciated values by only specific occupancy for each census block.

Figure 5-8: Depreciated Exposure Table

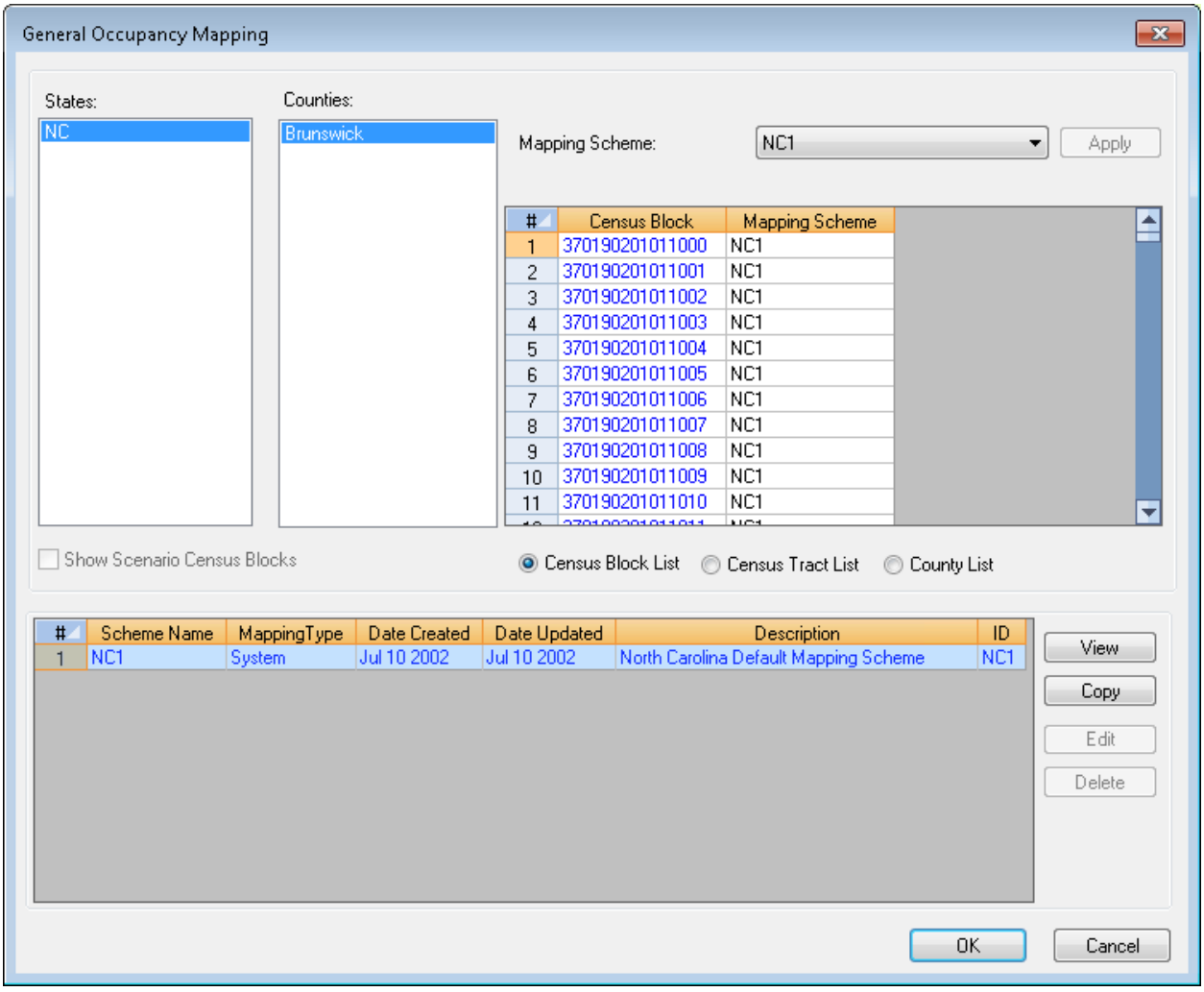


	CensusBlock	TotalExposure	Residential	Commercial	Industrial	Agriculture
1	370190201011000	0	0	0	0	0
2	370190201011001	0	0	0	0	0
3	370190201011002	0	0	0	0	0
4	370190201011003	714	436	0	0	0
5	370190201011004	151	151	0	0	0
6	370190201011005	497	497	0	0	0
7	370190201011006	398	398	0	0	0
8	370190201011007	501	486	0	15	0
9	370190201011008	0	0	0	0	0
10	370190201011009	231	231	0	0	0
11	370190201011010	0	0	0	0	0
12	370190201011011	411	411	0	0	0
13	370190201011012	0	0	0	0	0
14	370190201011013	0	0	0	0	0
15	370190201011014	697	697	0	0	0
16	370190201011015	0	0	0	0	0
17	370190201011016	55	0	0	55	0

5.1.7 General Occupancy Mapping

The **General Occupancy Mapping** window (Figure 5-9) allows the user to view, copy, edit, and delete the distribution of general building types in the Study Region. By default, the specific state distribution is the only scheme available. This data can be viewed and copied but cannot be edited or deleted. The user can make a copy of the default data (by selecting the default data and clicking **Copy** and entering a new scheme name and description) and edit this data (by clicking the new copy and clicking **Edit**).

Figure 5-9: General Occupancy Mapping Schemes



5.1.8 Flood Specific Occupancy Mapping

Flood Specific Occupancy Mapping (Figure 5-10) allows the user to view the default assumptions for physical building characteristics of structures in any specific occupancy category. There are three default mapping schemes (Coastal, Great Lakes, and Riverine). All three schemes can be copied and the copy versions can be edited to create custom schemes.

For example, to view the Pre- and Post-FIRM (Flood Insurance Rate Map) distributions of foundation types for all RES1 buildings, select a **Mapping Scheme** and click **View**. Figure 5-11 shows the **Flood Building Characteristics Distribution** window that will appear. Users can create custom schemes by clicking the **Copy** button, which activates the **Edit** button. Click **Edit** to change percentage values in the copy.

Figure 5-10: Flood-Specific Occupancy Mapping Schemes

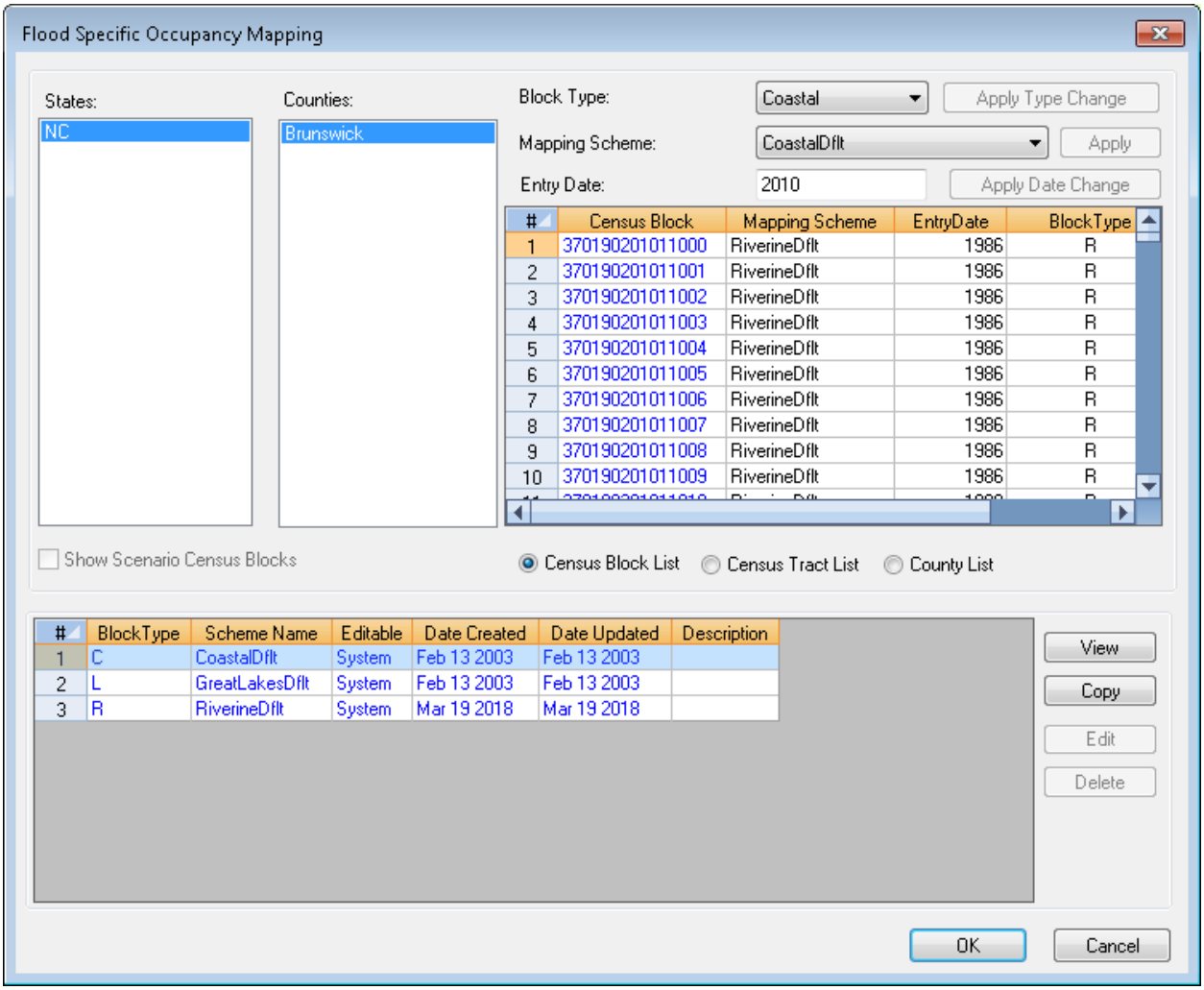
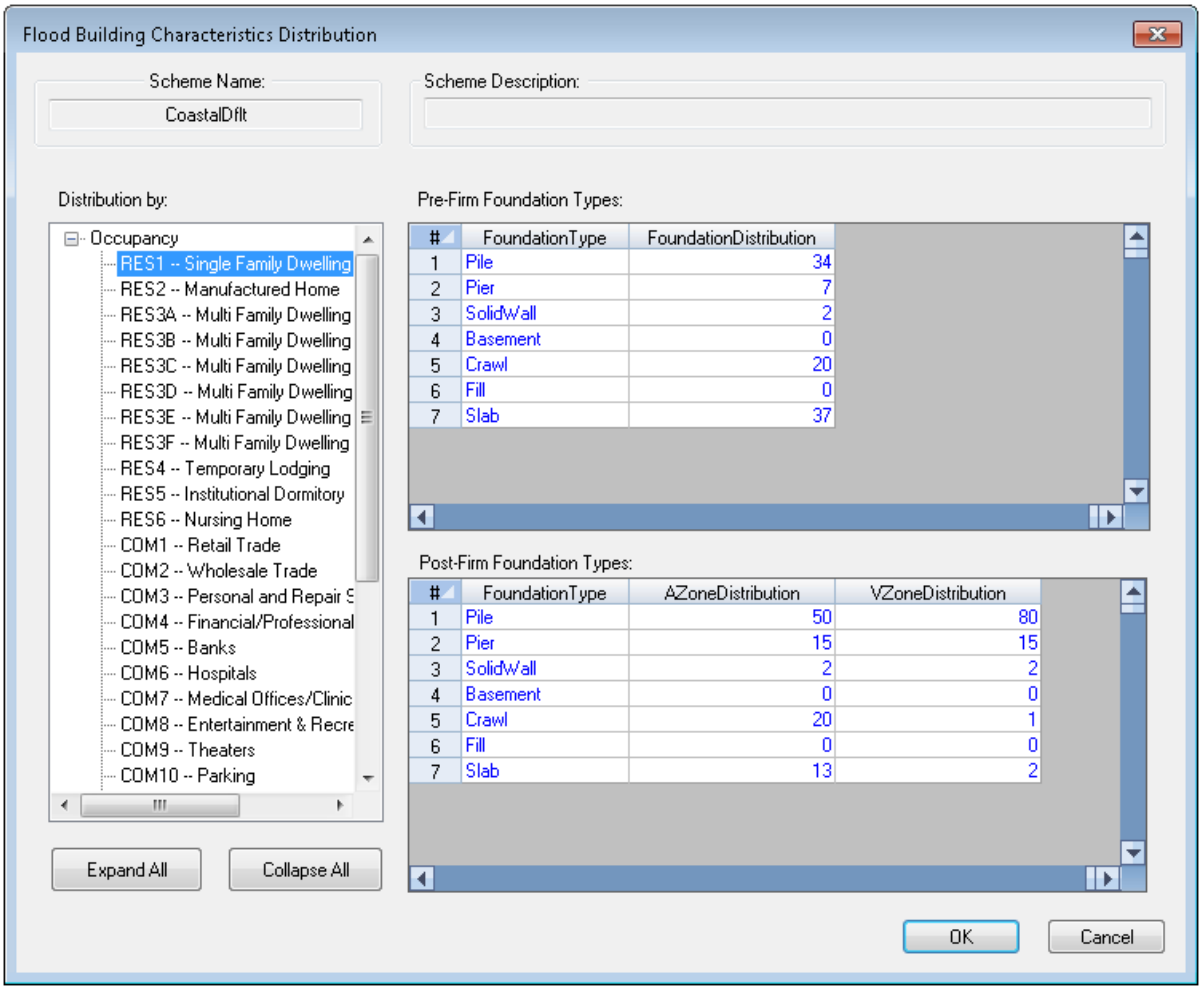


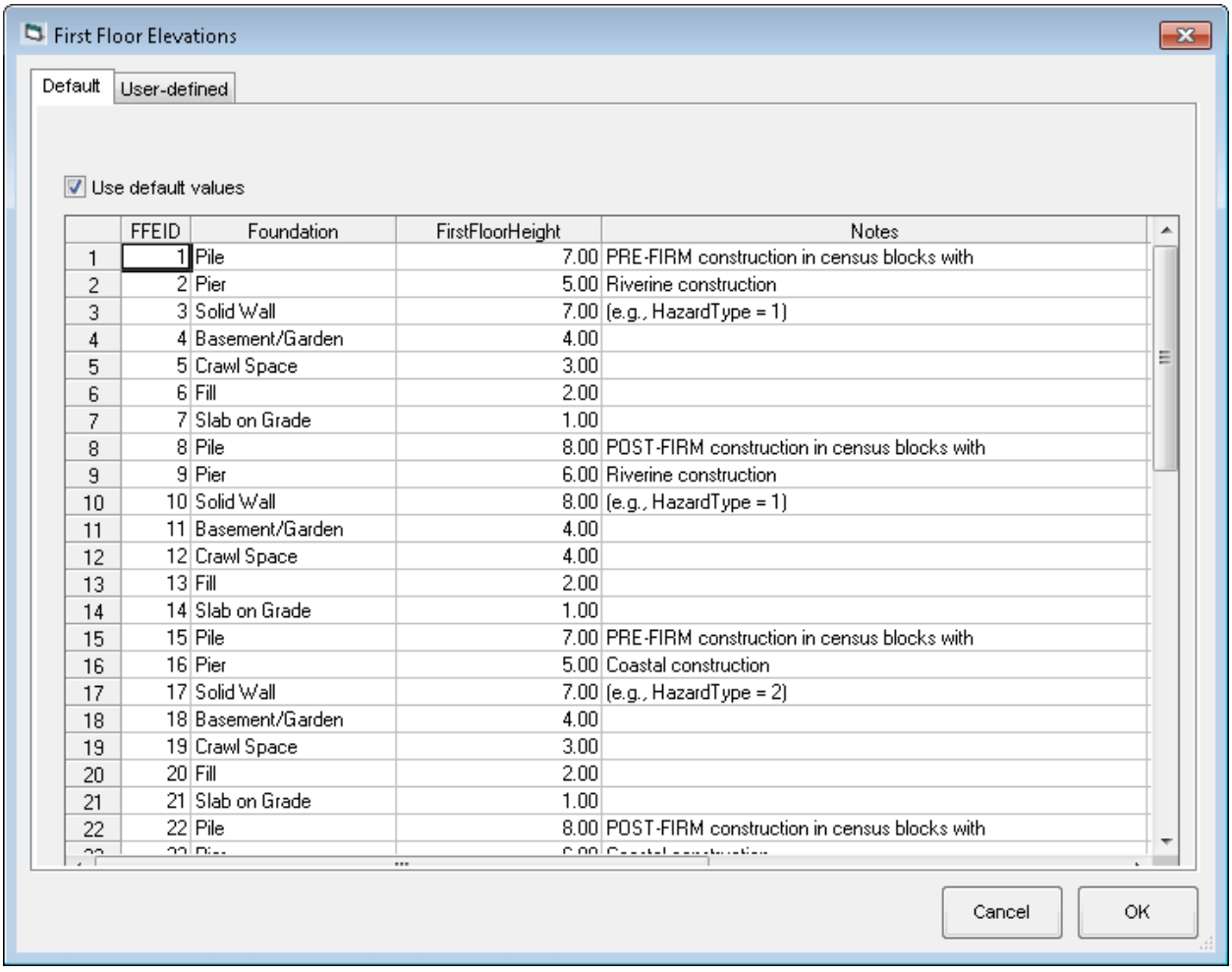
Figure 5-11: Flood Building Characteristics Distribution



5.1.9 First Floor Elevations Flood-Specific Occupancy Mapping

The **First Floor Elevations** window (Figure 5-12) allows the user to view the default assumptions for first floor heights of various foundation types. User-defined first floor heights can be assigned by clicking on the **User-defined** tab and selecting the **Use user-defined values** check box. Edit the first floor height values for the foundation types and click **OK**.

Figure 5-12: First Floor Elevations



	FFEID	Foundation	FirstFloorHeight	Notes
1	1	Pile	7.00	PRE-FIRM construction in census blocks with
2	2	Pier	5.00	Riverine construction
3	3	Solid Wall	7.00	(e.g., HazardType = 1)
4	4	Basement/Garden	4.00	
5	5	Crawl Space	3.00	
6	6	Fill	2.00	
7	7	Slab on Grade	1.00	
8	8	Pile	8.00	POST-FIRM construction in census blocks with
9	9	Pier	6.00	Riverine construction
10	10	Solid Wall	8.00	(e.g., HazardType = 1)
11	11	Basement/Garden	4.00	
12	12	Crawl Space	4.00	
13	13	Fill	2.00	
14	14	Slab on Grade	1.00	
15	15	Pile	7.00	PRE-FIRM construction in census blocks with
16	16	Pier	5.00	Coastal construction
17	17	Solid Wall	7.00	(e.g., HazardType = 2)
18	18	Basement/Garden	4.00	
19	19	Crawl Space	3.00	
20	20	Fill	2.00	
21	21	Slab on Grade	1.00	
22	22	Pile	8.00	POST-FIRM construction in census blocks with

5.2 Essential Facilities

Selecting **Essential Facilities** from the **Inventory** menu (Figure 5-13) will display the **Essential Facilities Inventory** table (Figure 5-14), which allows the user to view and map the locations and characteristics of medical care facilities, emergency centers, and schools.

Figure 5-13: Inventory / Essential Facilities Menu

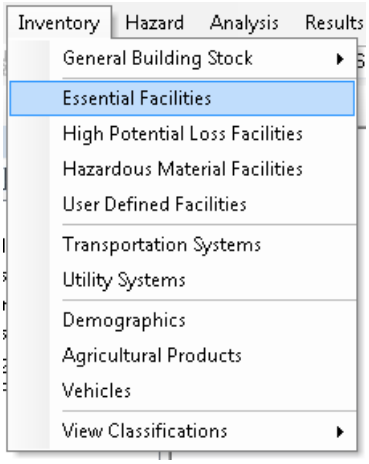
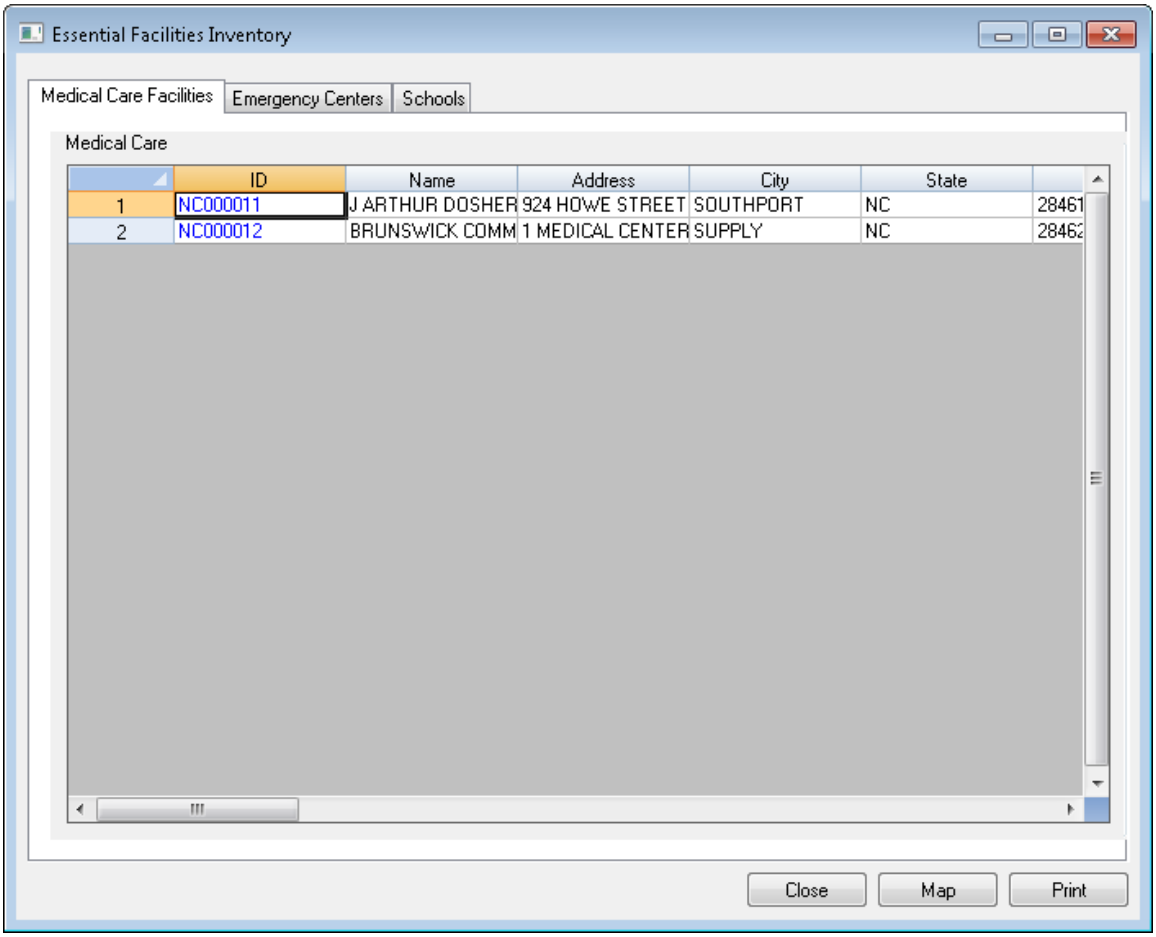


Figure 5-14: Essential Facilities (Medical Care Facilities) Table



5.3 High Potential Loss Facilities

Selecting **High Potential Loss Facilities** from the **Inventory** menu (Figure 5-15) will display the **High Potential Loss Facilities** table (Figure 5-16), which allows the user to view and map the locations and some characteristics of dams, levees, nuclear power plants, and military installations.

Figure 5-15: Inventory / High Potential Loss Facilities Menu

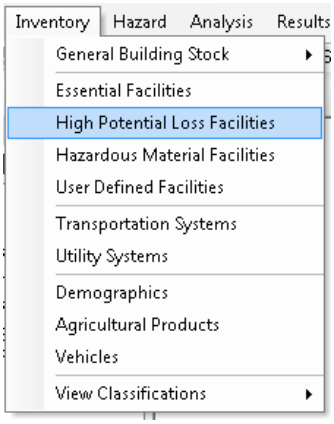
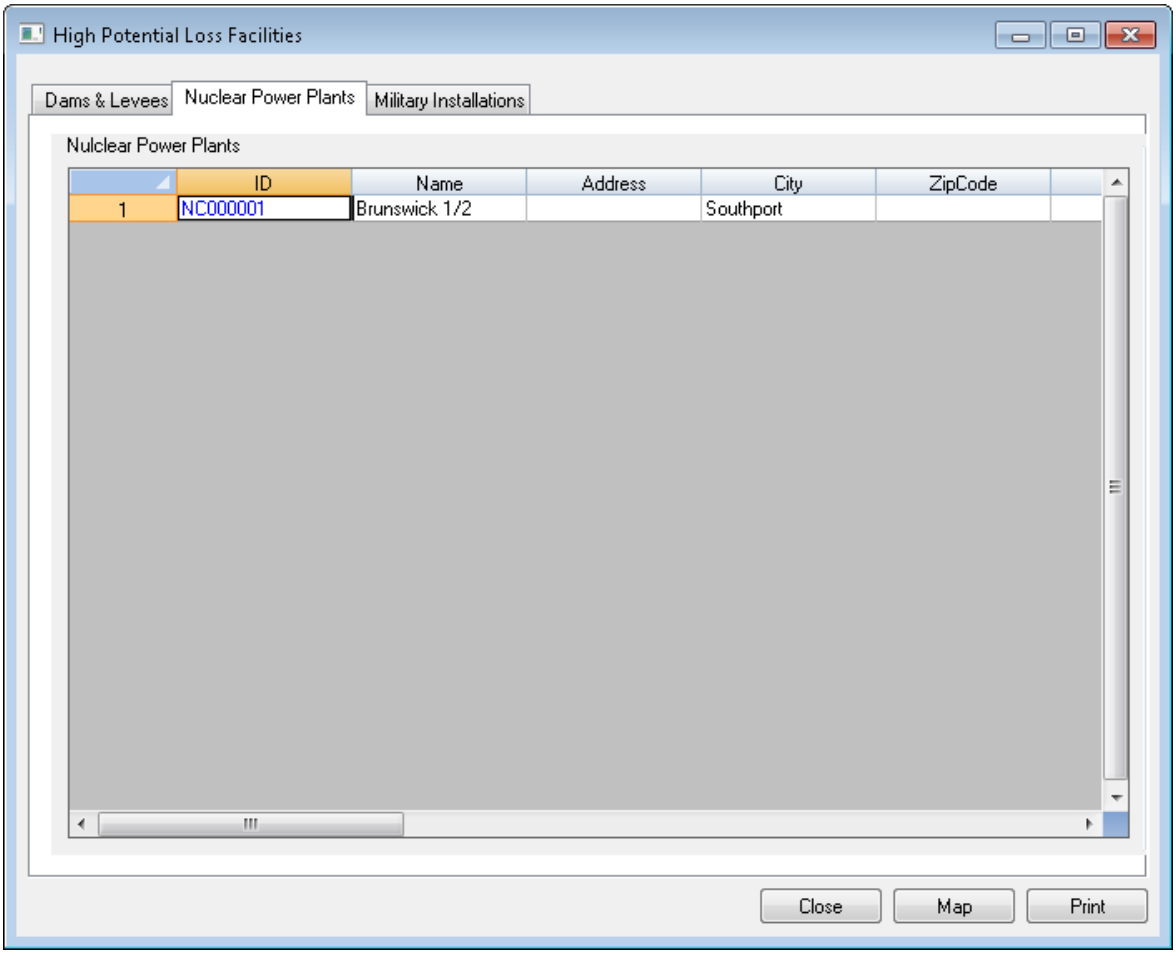


Figure 5-16: High Potential Loss Facilities (Nuclear Power Plants) Table



5.4 Hazardous Materials Facilities

Selecting **Hazardous Materials Facilities** from the **Inventory** menu (Figure 5-17) will display the **Hazardous Materials** table (Figure 5-18), which allows the user to view and map the locations and characteristics of hazardous materials sites.

Figure 5-17: Inventory / Hazardous Materials Facilities Menu

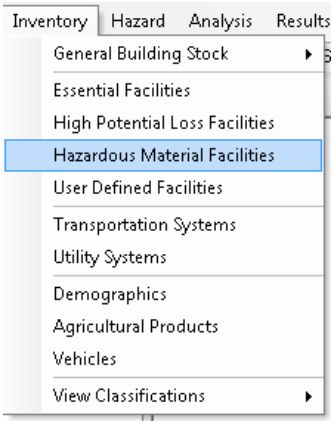
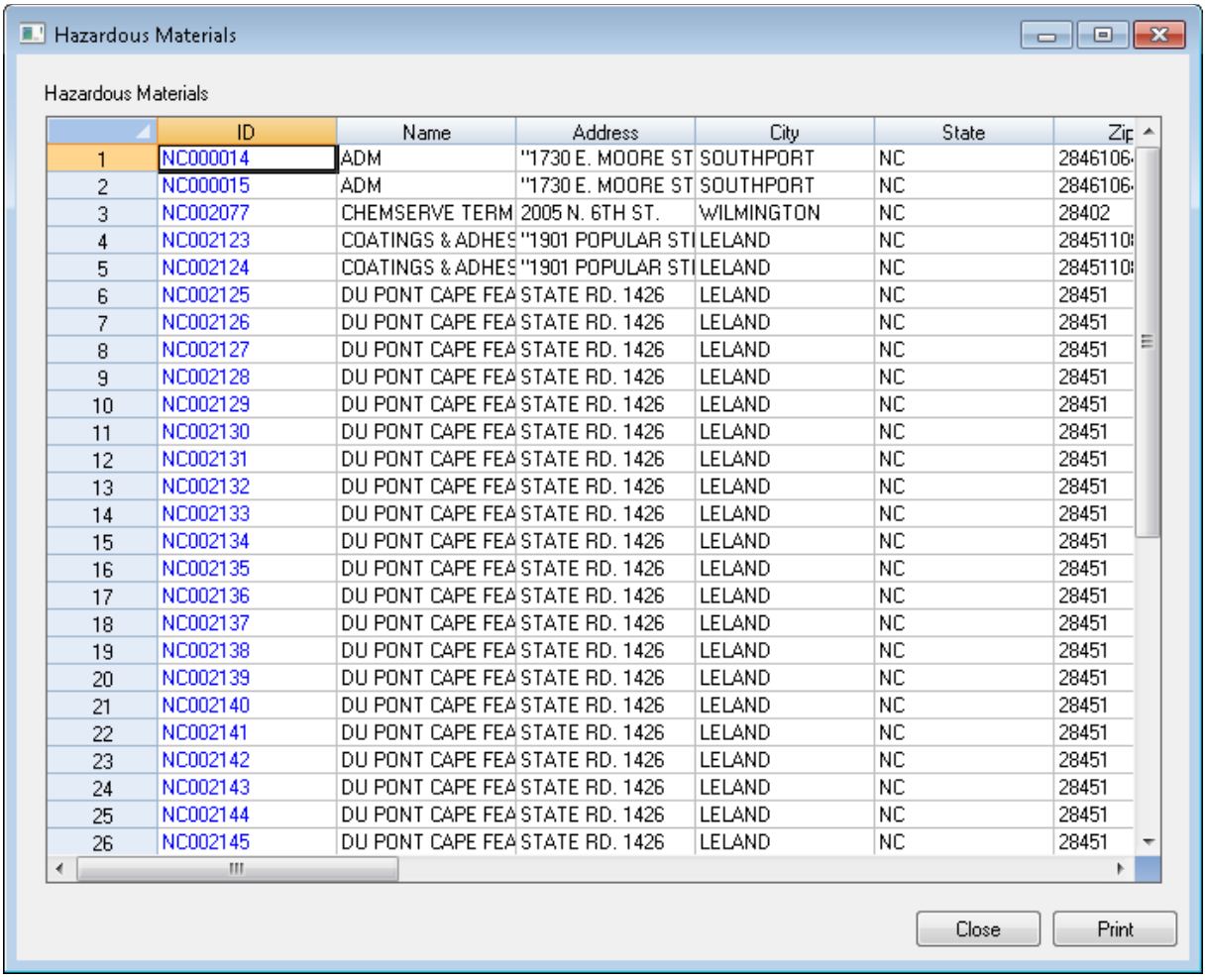


Figure 5-18: Hazardous Materials Table



	ID	Name	Address	City	State	Zip
1	NC000014	ADM	"1730 E. MOORE ST	SOUTHPORT	NC	2846106
2	NC000015	ADM	"1730 E. MOORE ST	SOUTHPORT	NC	2846106
3	NC002077	CHEMSERVE TERM	2005 N. 6TH ST.	WILMINGTON	NC	28402
4	NC002123	COATINGS & ADHES	"1901 POPULAR ST	LELAND	NC	2845110
5	NC002124	COATINGS & ADHES	"1901 POPULAR ST	LELAND	NC	2845110
6	NC002125	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
7	NC002126	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
8	NC002127	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
9	NC002128	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
10	NC002129	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
11	NC002130	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
12	NC002131	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
13	NC002132	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
14	NC002133	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
15	NC002134	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
16	NC002135	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
17	NC002136	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
18	NC002137	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
19	NC002138	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
20	NC002139	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
21	NC002140	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
22	NC002141	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
23	NC002142	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
24	NC002143	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
25	NC002144	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451
26	NC002145	DU PONT CAPE FEA	STATE RD. 1426	LELAND	NC	28451

5.5 User-Defined Facilities

Selecting **User-Defined Facilities** from the **Inventory** menu (Figure 5-19) will display the **User-Defined Facilities** table (Figure 5-20), which allows the user to view and map the locations and characteristics of any facilities that have been imported by the user.

Figure 5-19: Inventory / User-Defined Facilities Menu

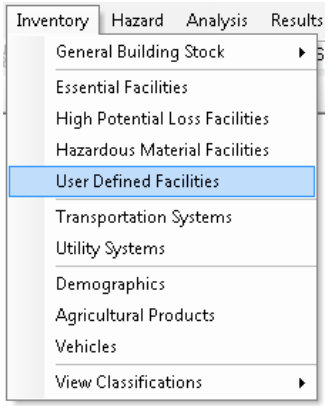
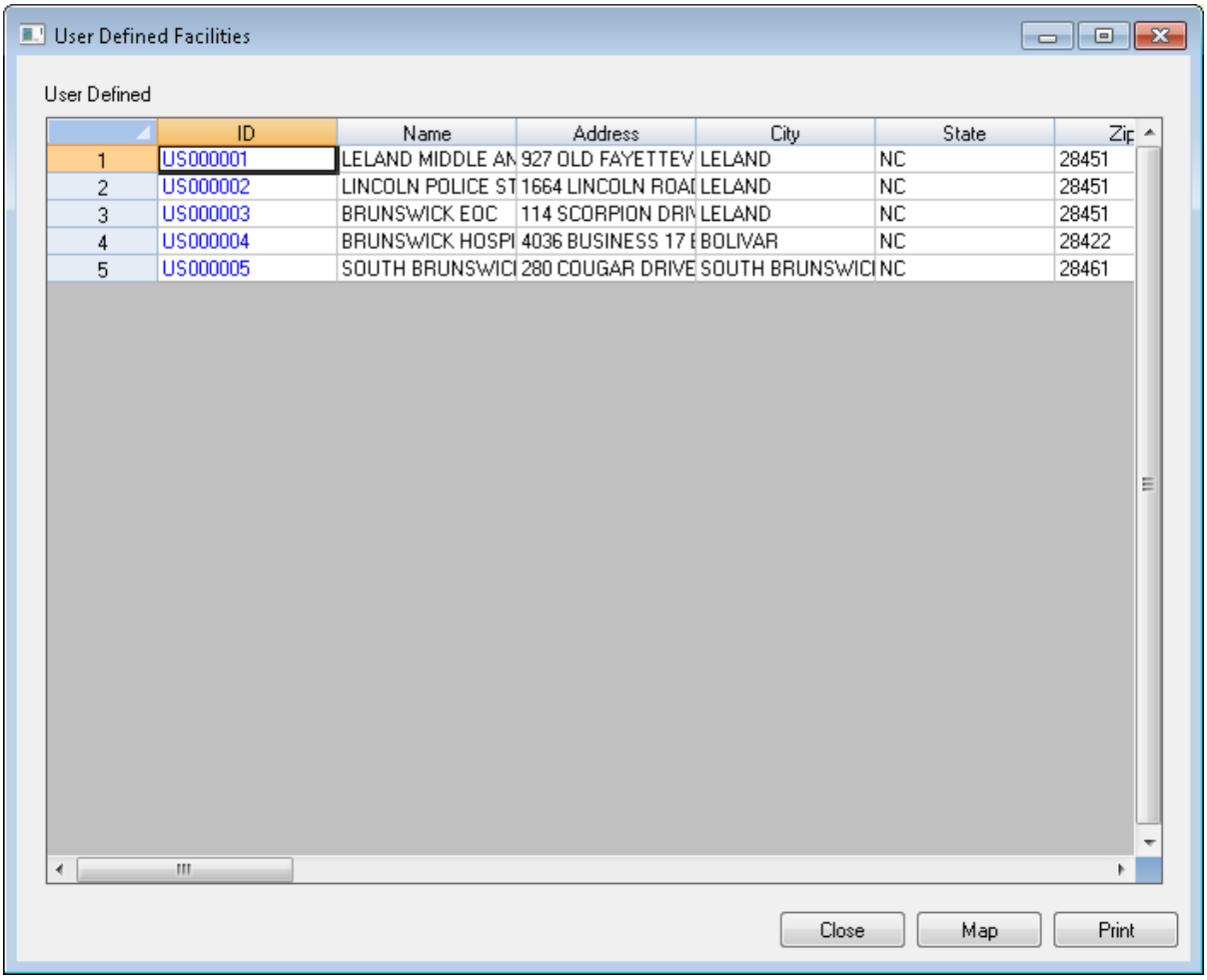


Figure 5-20: User-Defined Facilities Table



5.6 Transportation Systems

Selecting **Transportation Systems** from the **Inventory** menu (Figure 5-21) will display the **Transportation Systems Inventory Data** table (Figure 5-22), which allows the user to view and map the location and characteristics of highways, railways light rails, buses, ports, ferries, and airports.

Figure 5-21: Inventory / Transportation Systems Menu

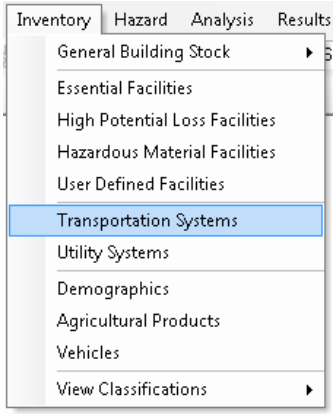
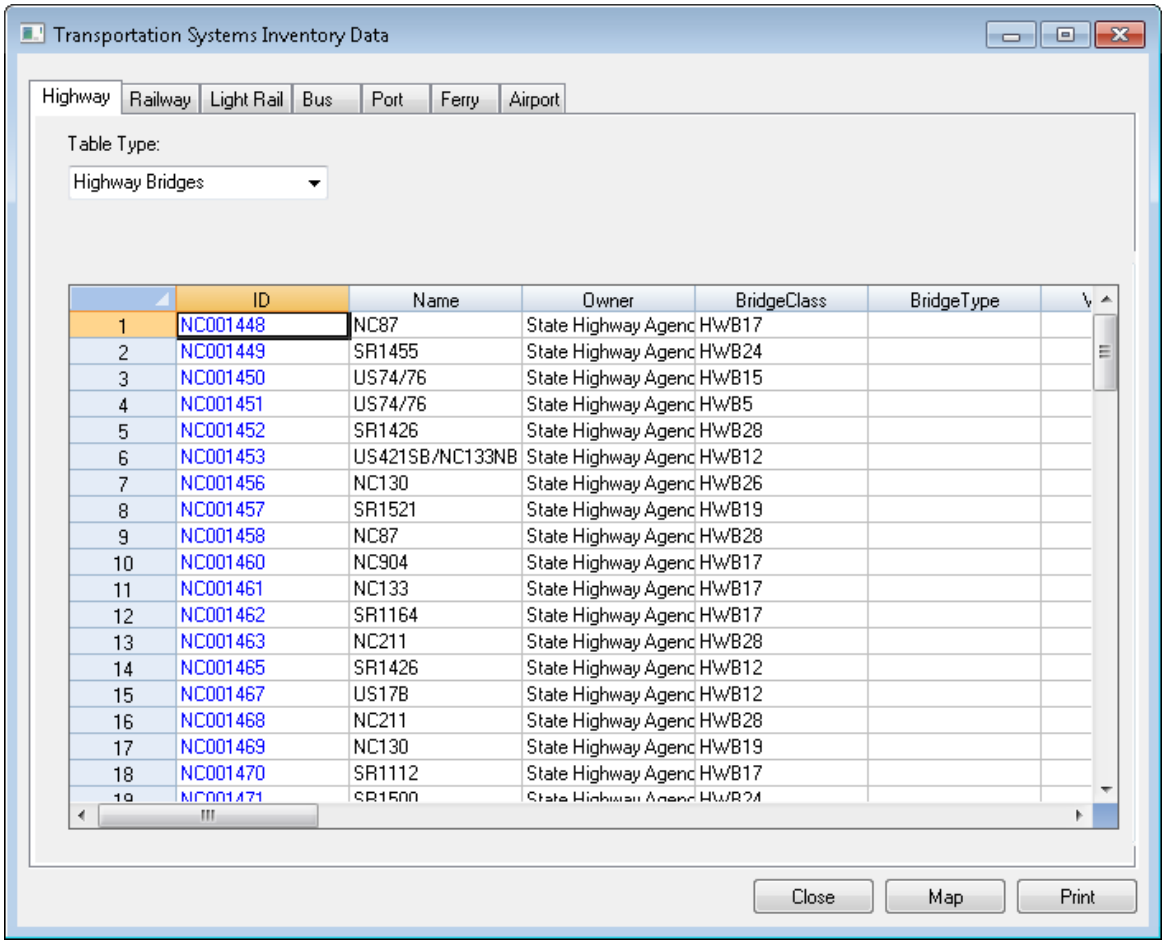


Figure 5-22: Transportation Systems Table



	ID	Name	Owner	BridgeClass	BridgeType
1	NC001448	NC87	State Highway Agenc	HWB17	
2	NC001449	SR1455	State Highway Agenc	HWB24	
3	NC001450	US74/76	State Highway Agenc	HWB15	
4	NC001451	US74/76	State Highway Agenc	HWB5	
5	NC001452	SR1426	State Highway Agenc	HWB28	
6	NC001453	US421SB/NC133NB	State Highway Agenc	HWB12	
7	NC001456	NC130	State Highway Agenc	HWB26	
8	NC001457	SR1521	State Highway Agenc	HWB19	
9	NC001458	NC87	State Highway Agenc	HWB28	
10	NC001460	NC904	State Highway Agenc	HWB17	
11	NC001461	NC133	State Highway Agenc	HWB17	
12	NC001462	SR1164	State Highway Agenc	HWB17	
13	NC001463	NC211	State Highway Agenc	HWB28	
14	NC001465	SR1426	State Highway Agenc	HWB12	
15	NC001467	US17B	State Highway Agenc	HWB12	
16	NC001468	NC211	State Highway Agenc	HWB28	
17	NC001469	NC130	State Highway Agenc	HWB19	
18	NC001470	SR1112	State Highway Agenc	HWB17	
19	NC001471	SR1500	State Highway Agenc	HWB24	

5.7 Utility Systems

Selecting **Utility Systems** from the **Inventory** menu (Figure 5-23) will display the **Utility Systems Inventory** table (Figure 5-24), which allows the user to view and map the locations and characteristics of facilities for potable water, waste water, oil, natural gas, electric power, and communications.

Figure 5-23: Inventory / Utility Systems Menu

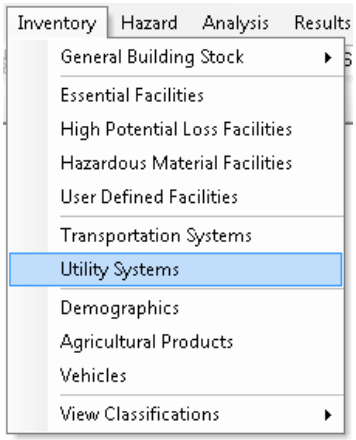
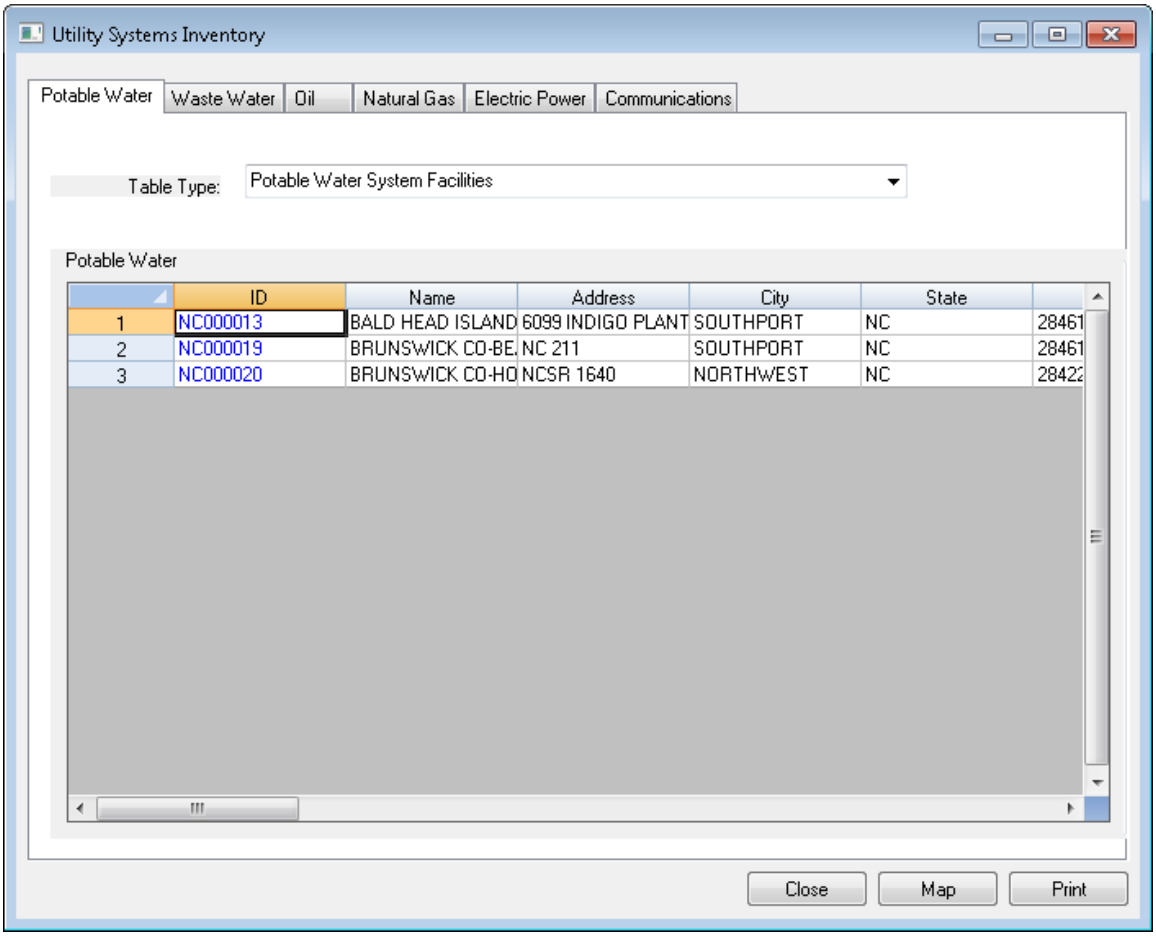


Figure 5-24: Utility Systems Table



5.8 Demographics

Selecting **Demographics** from the **Inventory** menu (Figure 5-25) will display the **Demographics** table (Figure 5-26), which allows the user to view and map categorical census data aggregated by census block.

Figure 5-25: Inventory / Demographics Menu

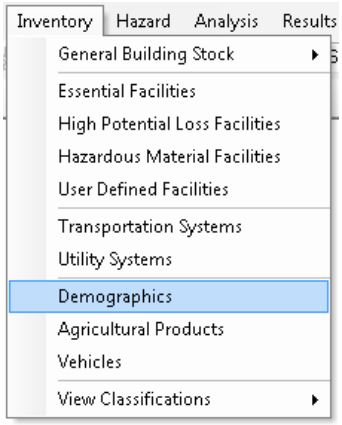
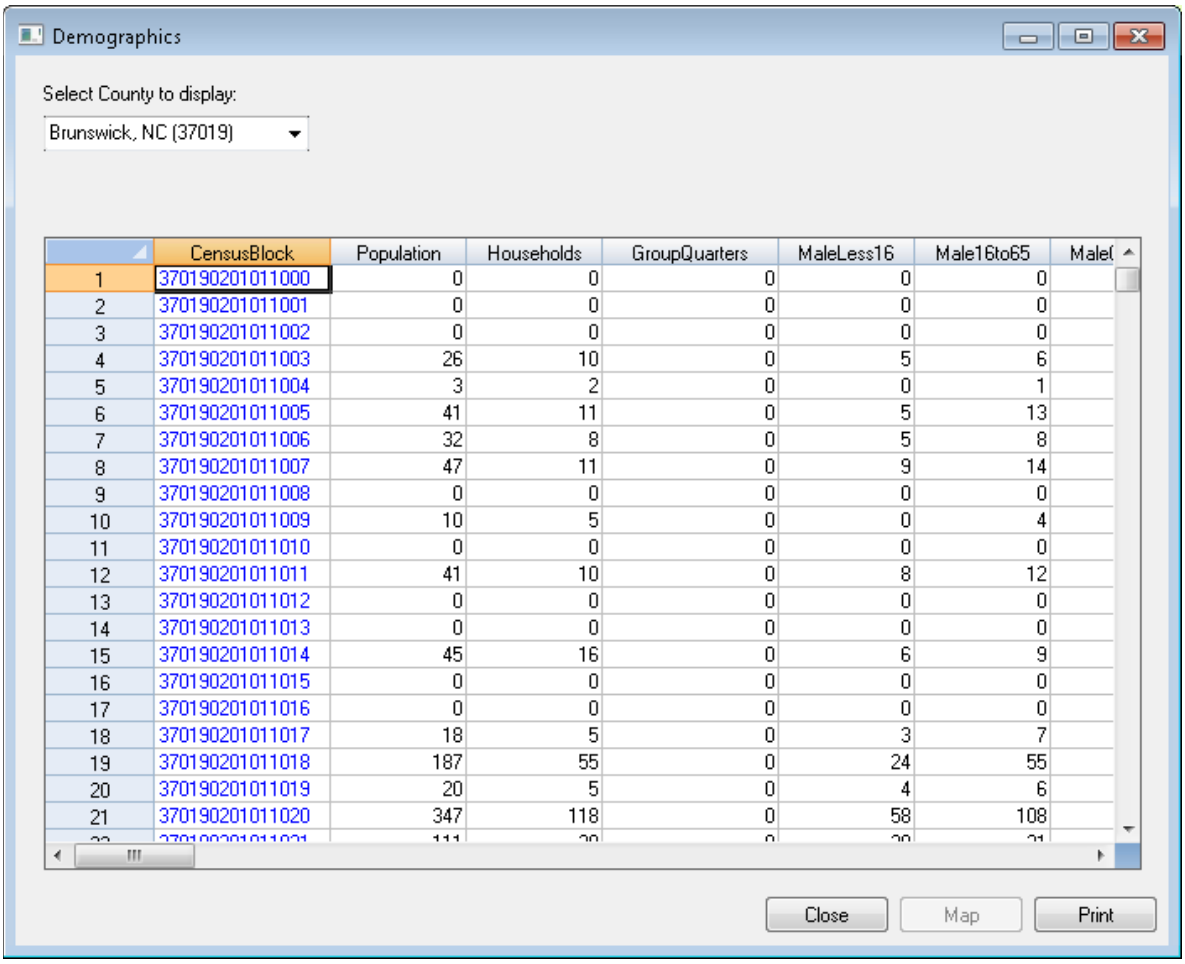


Figure 5-26: Demographics Table



	CensusBlock	Population	Households	GroupQuarters	MaleLess16	Male16to65	Male(
1	370190201011000	0	0	0	0	0	
2	370190201011001	0	0	0	0	0	
3	370190201011002	0	0	0	0	0	
4	370190201011003	26	10	0	5	6	
5	370190201011004	3	2	0	0	1	
6	370190201011005	41	11	0	5	13	
7	370190201011006	32	8	0	5	8	
8	370190201011007	47	11	0	9	14	
9	370190201011008	0	0	0	0	0	
10	370190201011009	10	5	0	0	4	
11	370190201011010	0	0	0	0	0	
12	370190201011011	41	10	0	8	12	
13	370190201011012	0	0	0	0	0	
14	370190201011013	0	0	0	0	0	
15	370190201011014	45	16	0	6	9	
16	370190201011015	0	0	0	0	0	
17	370190201011016	0	0	0	0	0	
18	370190201011017	18	5	0	3	7	
19	370190201011018	187	55	0	24	55	
20	370190201011019	20	5	0	4	6	
21	370190201011020	347	118	0	58	108	

5.9 Agricultural Products

Selecting **Agricultural Products** from the **Inventory** menu (Figure 5-27) will display the **Agricultural Products** table (Figure 5-28), which allows the user to view the types and amounts of crops produced in the Study Region.

Figure 5-27: Inventory / Agricultural Products Menu

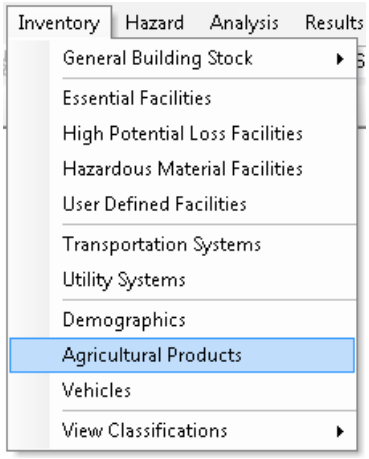
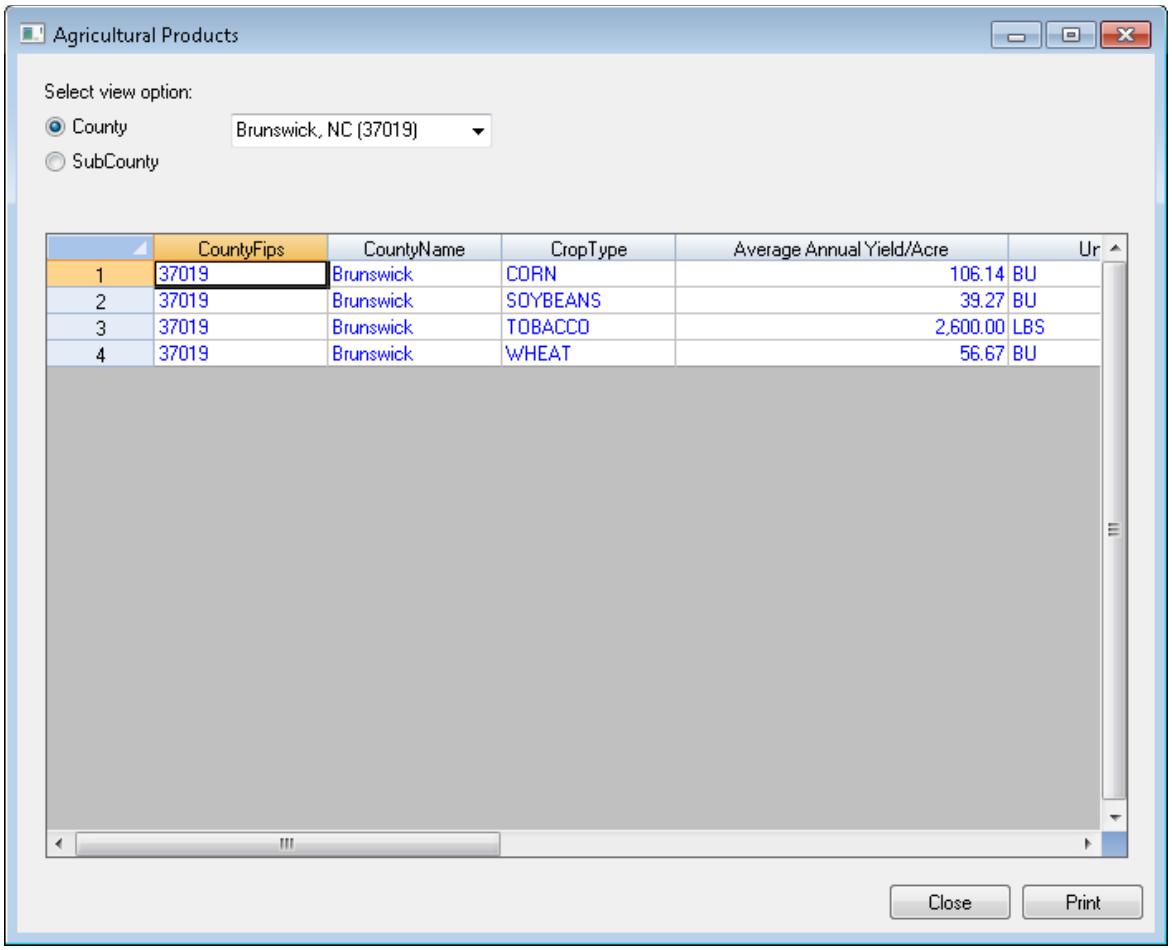


Figure 5-28: Agricultural Products Table



5.10 Vehicles

Selecting **Vehicles** from the **Inventory** menu (Figure 5-29) will display the **Vehicles** table (Figure 5-30), which shows two tabs with information about vehicle count and dollar exposure by census block. The table can be changed to show daytime or nighttime values using the **Day / Night** dropdown. These values are estimated based primarily on the building occupancies in each census block.

Figure 5-29: Inventory / Vehicles Menu

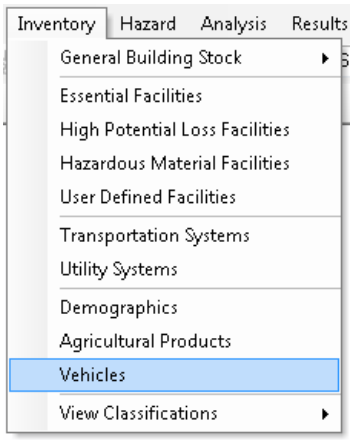
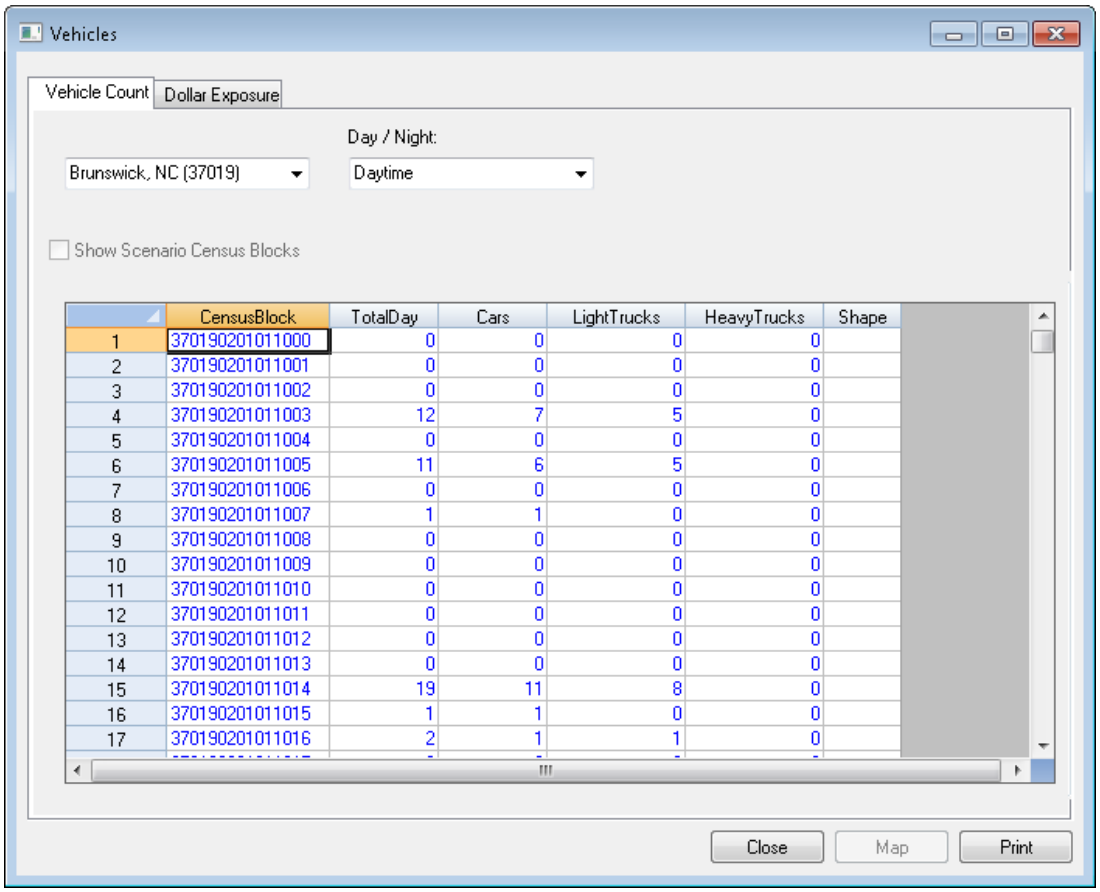


Figure 5-30: Vehicles (Vehicle Count) Table

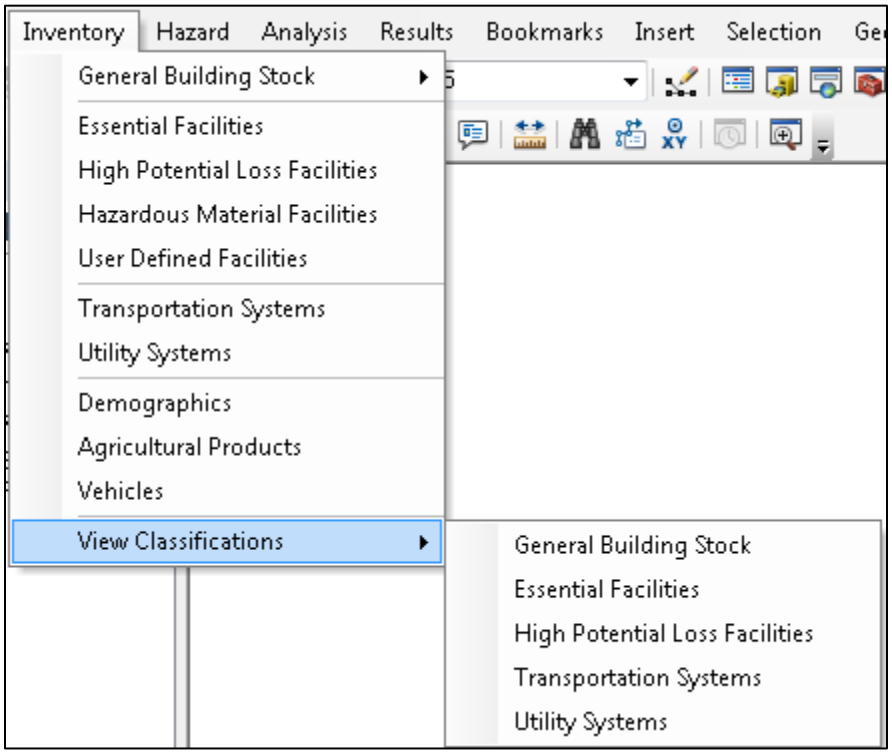


	CensusBlock	TotalDay	Cars	LightTrucks	HeavyTrucks	Shape
1	370190201011000	0	0	0	0	
2	370190201011001	0	0	0	0	
3	370190201011002	0	0	0	0	
4	370190201011003	12	7	5	0	
5	370190201011004	0	0	0	0	
6	370190201011005	11	6	5	0	
7	370190201011006	0	0	0	0	
8	370190201011007	1	1	0	0	
9	370190201011008	0	0	0	0	
10	370190201011009	0	0	0	0	
11	370190201011010	0	0	0	0	
12	370190201011011	0	0	0	0	
13	370190201011012	0	0	0	0	
14	370190201011013	0	0	0	0	
15	370190201011014	19	11	8	0	
16	370190201011015	1	1	0	0	
17	370190201011016	2	1	1	0	

5.11 View Classifications

View Classifications (Figure 5-31) allows users to view definitions of the classification categories. The subtypes are **General Building Stock**, **Essential Facilities**, **High Potential Loss Facilities**, **Transportation Systems**, and **Utility Systems**, as shown in Figure 5-31.

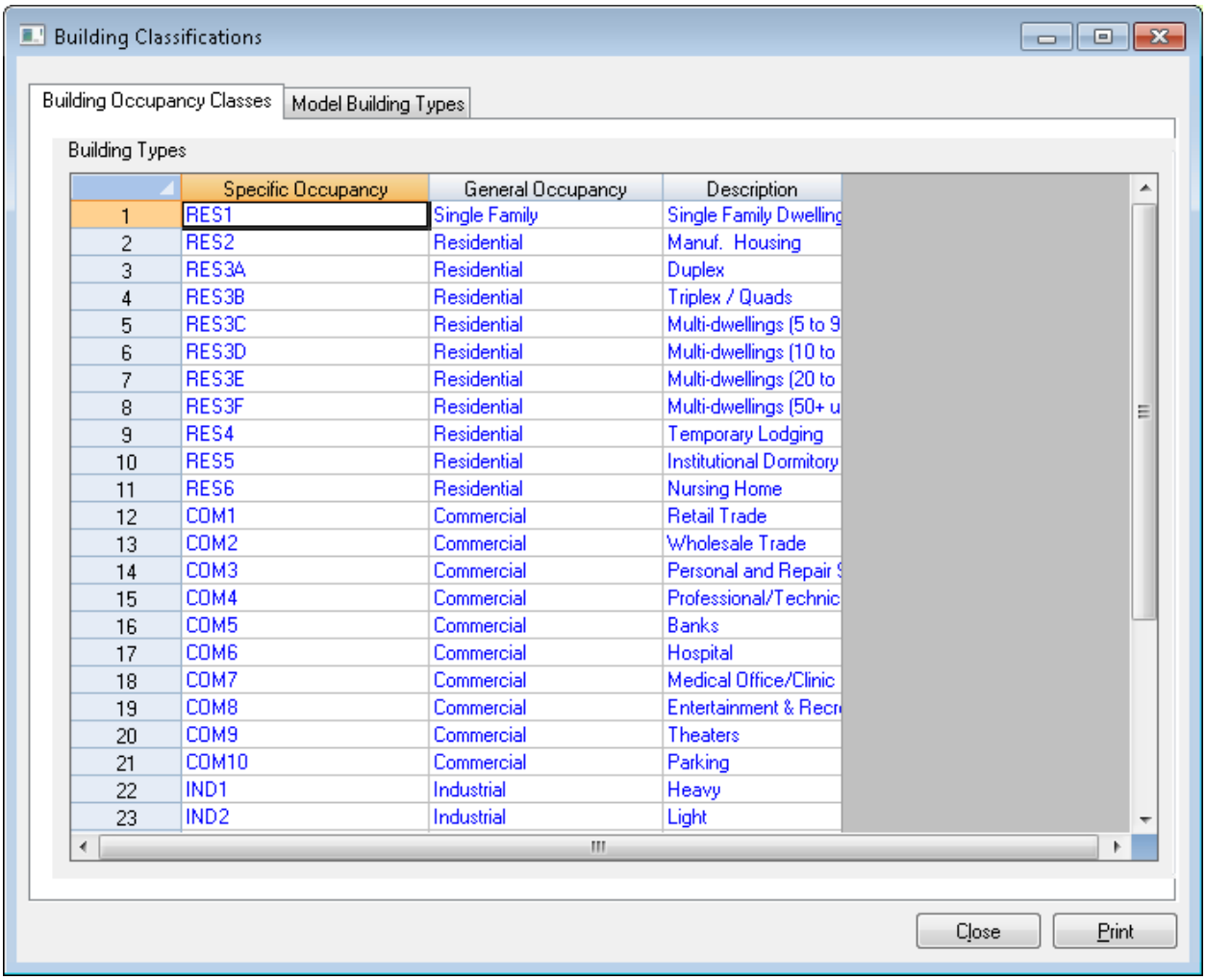
Figure 5-31: Inventory / View Classifications Menu



5.11.1 General Building Stock Classifications

The **Buildings Classifications** table (Figure 5-32) allows the user to view the assumptions used to define values for **Building Occupancy Classes** and **Model Building Types**.

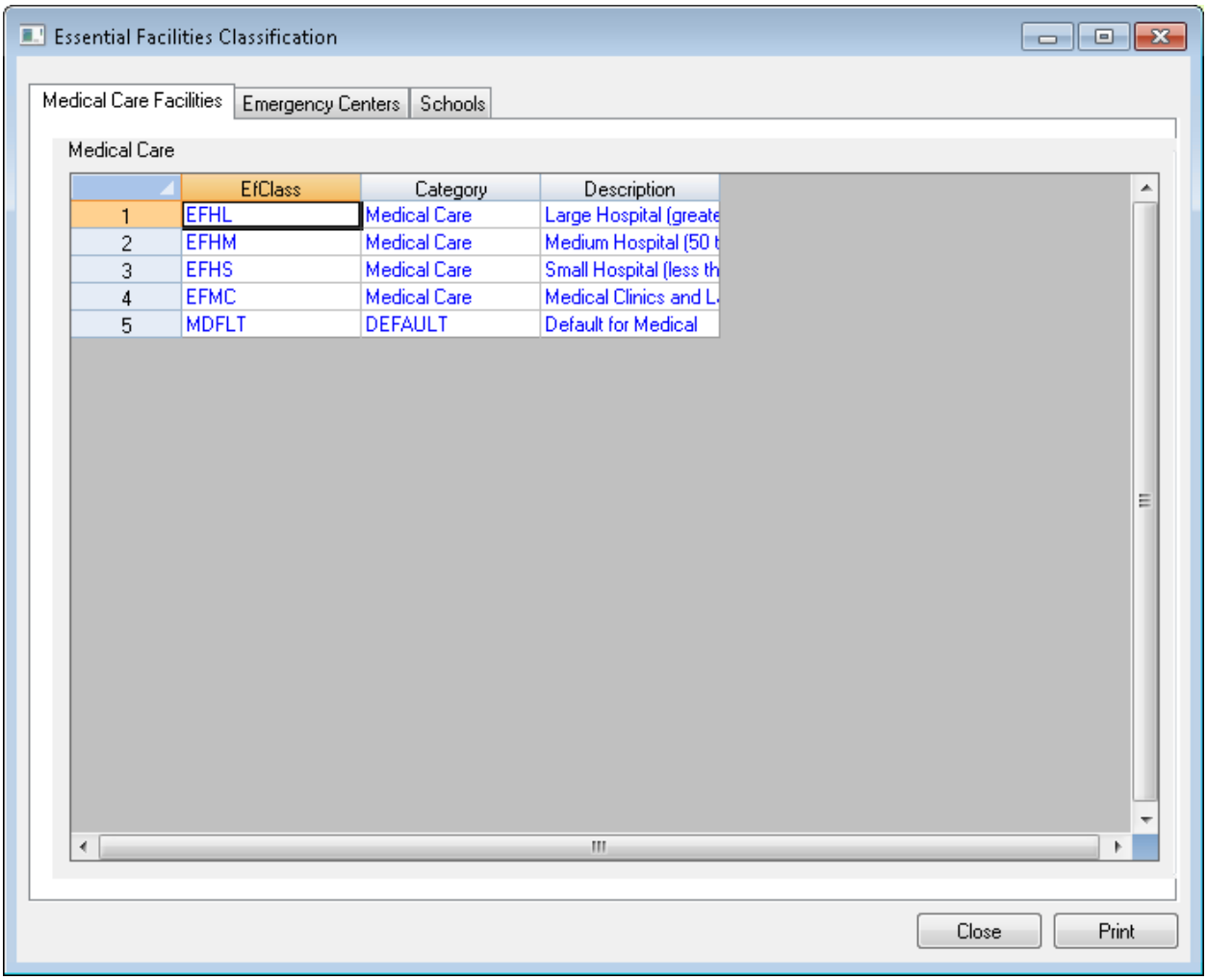
Figure 5-32: Buildings Classifications Table



5.11.2 Essential Facilities Classification

The **Essential Facilities Classifications** table (Figure 5-33) allows the user to view the assumptions used to define values for **Medical Care Facilities**, **Emergency Centers**, and **Schools**.

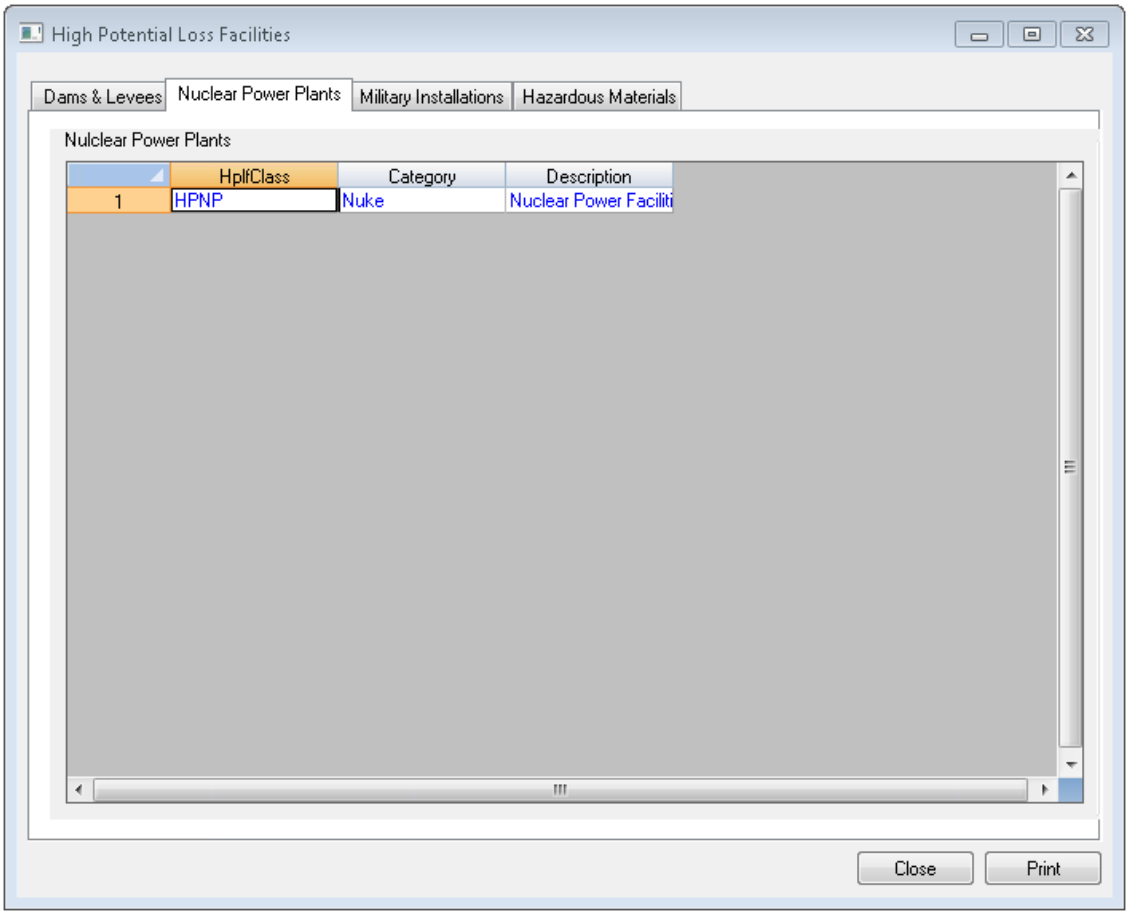
Figure 5-33: Essential Facilities Classification Table



5.11.3 High Potential Loss Facilities Classification

The **High Potential Loss Facilities Classification** table (Figure 5-34) allows the user to view the assumptions used to define values for **Dams & Levees**, **Nuclear Power Plants**, **Military Installations**, and **Hazardous Materials**.

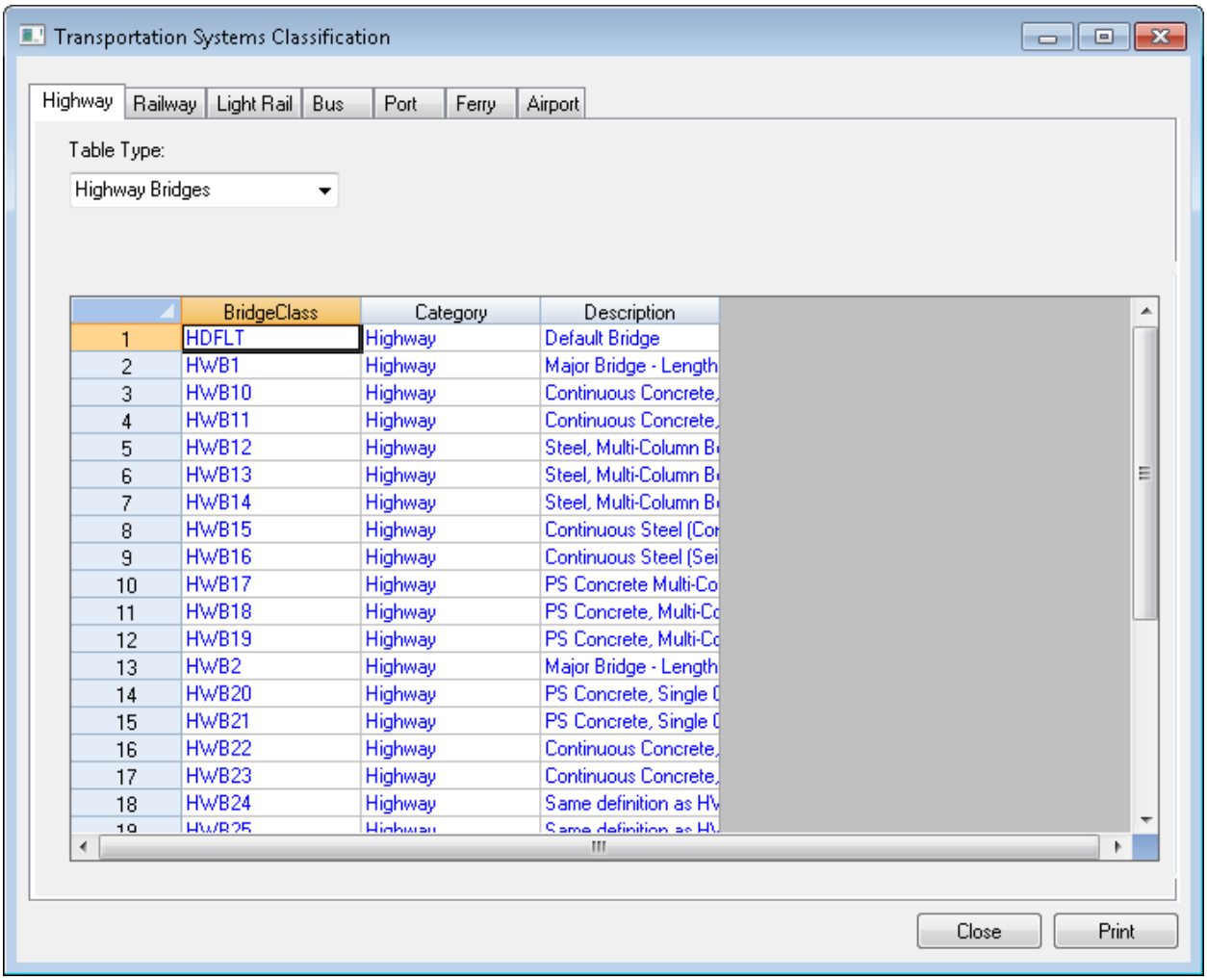
Figure 5-34: High Potential Loss Facilities Classification (Nuclear Power Plants) Table



5.11.4 Transportation Systems Classification

The **Transportation Systems Classification** table (Figure 5-35) allows the user to view the assumptions used to define values for **Highway**, **Railway**, **Light Rail**, **Bus**, **Port**, **Ferry**, and **Airport**.

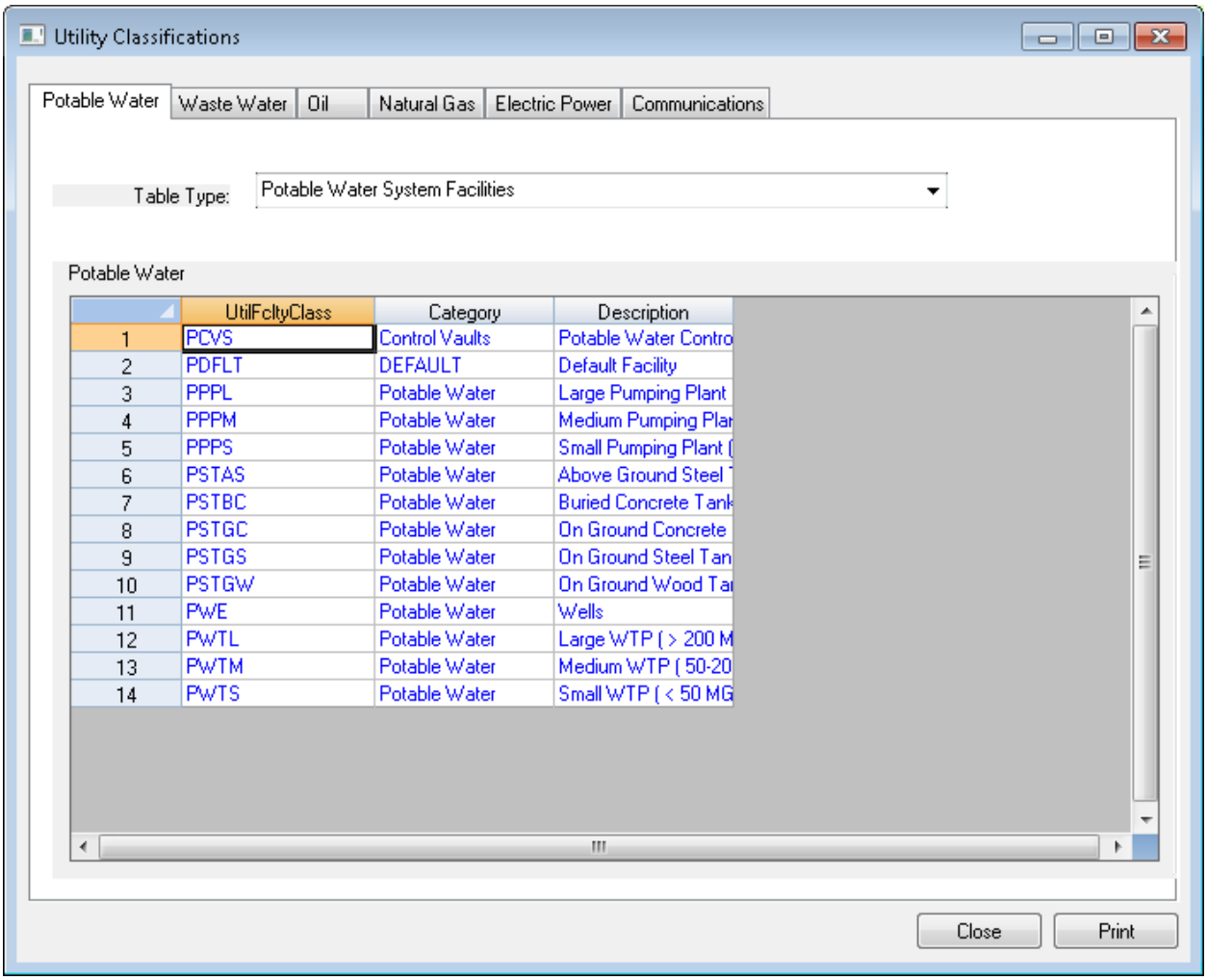
Figure 5-35: Transportation Systems Classification Table



5.11.5 Utility Classifications

The **Utility Classifications** table (Figure 5-36) allows the user to view the assumptions used to define values for **Potable Water**, **Waste Water**, **Oil**, **Natural Gas**, **Electric Power**, and **Communications**.

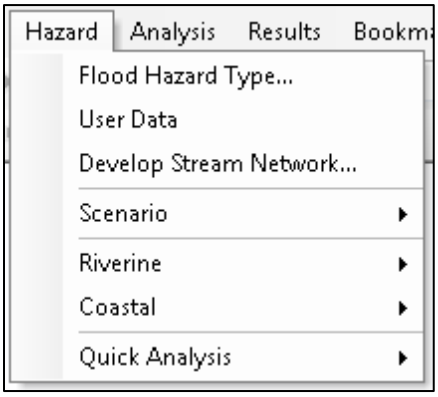
Figure 5-36: Utility Classifications Table



6 Model Menu: Hazard

The **Hazard** menu (Figure 6-1) within Hazus has a number of analysis types from which to choose. These options enable the user to select the appropriate analysis to perform on the Study Region. This section explains the selections and the inputs required for each.

Figure 6-1: Hazard Menu



6.1 Flood Hazard Type

The riverine and coastal hazards have different requirements for developing the hazard and the digital elevation data required to support the analysis.

The first option on the **Hazard** menu (Figure 6-2) is **Flood Hazard Type**. Selecting this option activates the **Flood Hazard Type** dialog shown in Figure 6-3. In this dialog, the user selects the Study Region's flood hazard type for analysis. The **Coastal surge** option is only enabled if the user is conducting a combined Hurricane and Flood hazard analysis and previously ran the Hurricane model.

The **Flood Hazard Type** selection on the **Hazard** menu (Figure 6-2) prevents users from having to supply unnecessary digital terrain data for the selected hazard type and enables only those menu items that are needed to support the hazard.

Figure 6-2: Select Flood Hazard Type

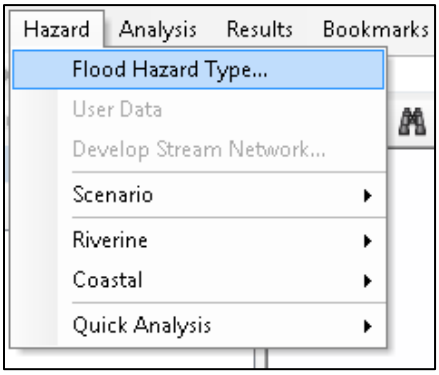
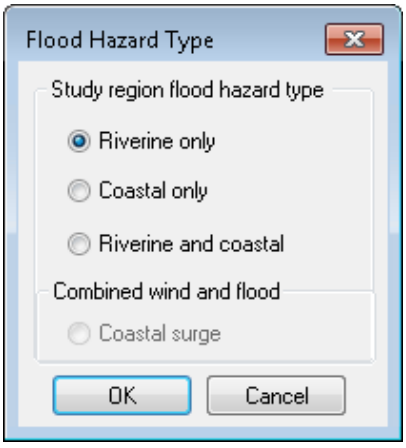


Figure 6-3: Flood Hazard Type Dialog



Users should think carefully about which hazard type (or both) they are interested in analyzing, as the selection will drive the entire hazard assessment. Changing the **Flood Hazard Type** selection will change the DEM requirements and prevent the user from accessing some of the menu items not applicable for that flood hazard type. For example, selection of the **Riverine only** button will require a DEM that covers both the Study Region and all the watersheds that intersect that Study Region and will require the user to develop a stream network, creating a Scenario (described later in this chapter). A coastal analysis does not require a stream network or hydrologic analysis, but does require a DEM for the coastal area of the Study Region.

6.2 User Data

The **User Data** selection from the **Hazard** menu (Figure 6-4) activates the window shown in Figure 6-5. Here, the user can select the appropriate tab to import the relevant data for the analysis. The **User Data** window offers four data import options: **DEM**, **FIT**, **Depth Grid**, and **HEC-RAS**. This chapter will provided details on using the DEM import option, while Chapter 12 provides more details on the other three options.

Figure 6-4: Select User Data

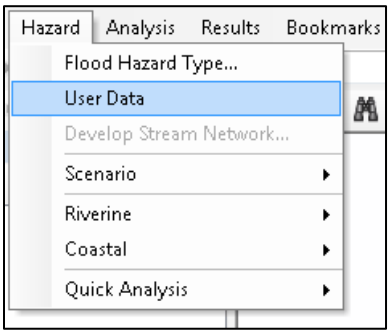
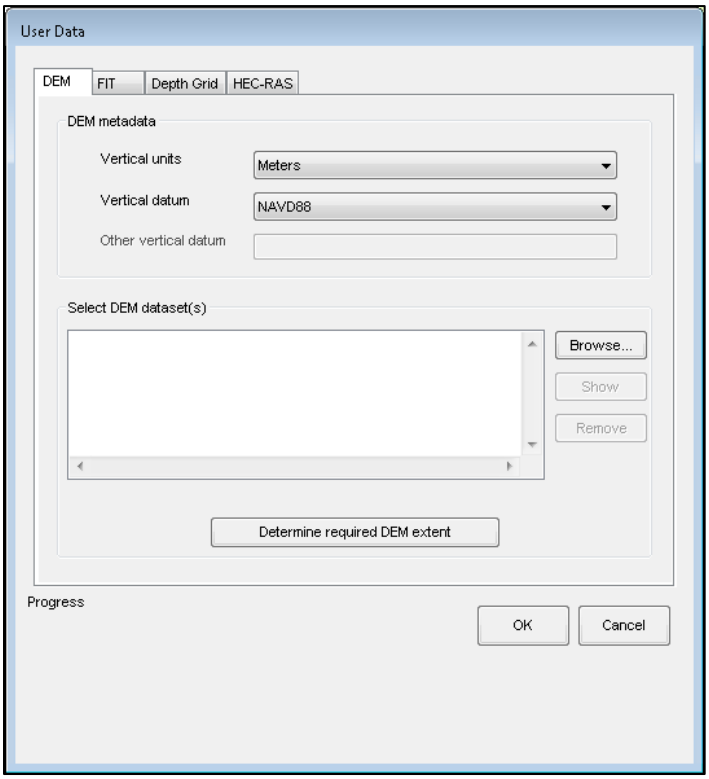


Figure 6-5: User Data Options Window

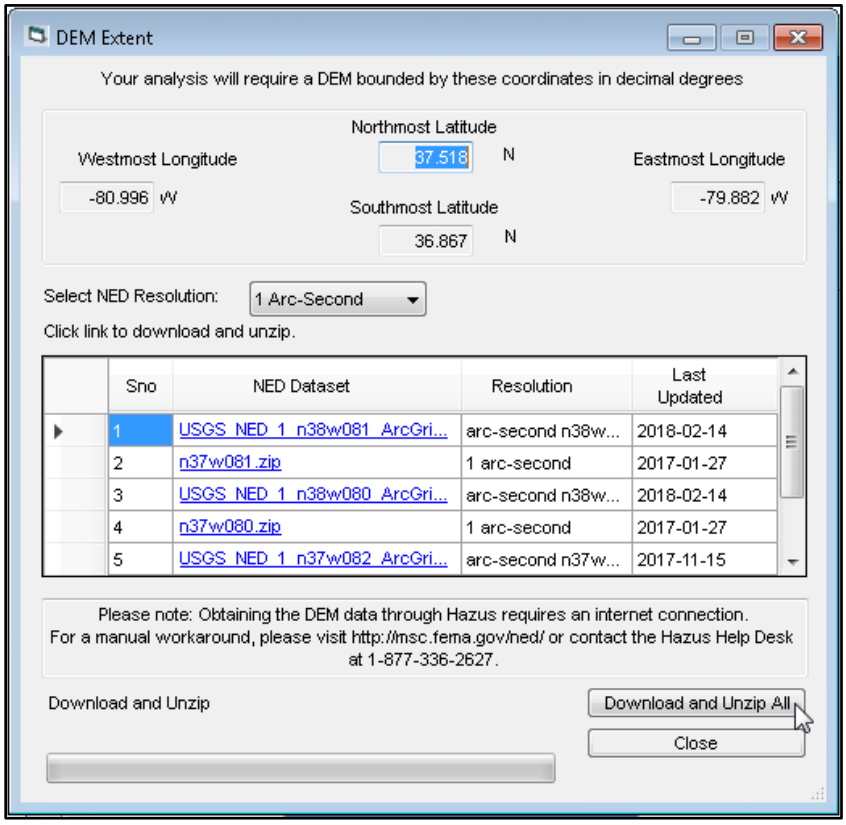


Click **Determine required DEM extent** shown in Figure 6-5 to have the Flood Model determine the DEM files required for the analysis. The extent will be different for riverine versus coastal flood analysis.

After a short pause, the **DEM Extent** window will appear, as shown in Figure 6-6. This window lists the required latitude and longitude coordinates that are needed to download the U.S. Geological Survey (USGS) DEM data. The latitude and longitude shown may extend beyond the defined boundaries of the Study Region because the watersheds that affect the region's flood risk probably extend outside the political boundaries.

Note that any DEM imported into the Flood Model must meet the bounding coordinate constraints established by this dialog. The Model will discontinue processing if it identifies gaps in the data coverage.

Figure 6-6: DEM Extent Window



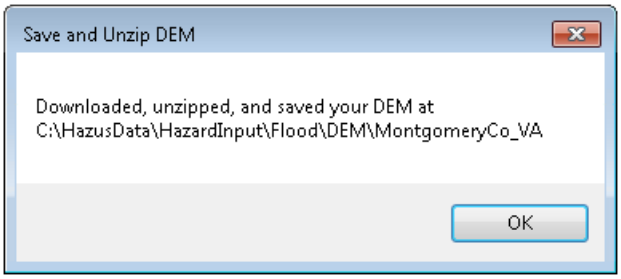
Use the **Select NED Resolution** dropdown menu to choose the desired resolution. The default is 1 Arc-Second (30 meters). Not all Study Regions will have available USGS DEM data for resolutions other than 1 Arc-Second. For example, choosing Alaska 2 Arc-Second for a Study Region in Montgomery County, VA will refresh the table and warn the user “No record found!”

6.2.1 Automated DEM Download

Click **Download and Unzip All** in the **DEM Extent** window shown in Figure 6-6 for Hazus to obtain all the required DEM files and save them within the Hazus Study Region folder.

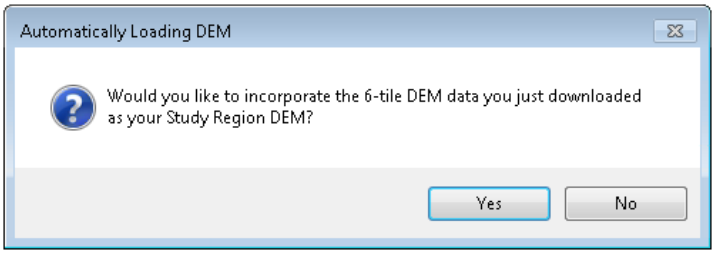
Hazus will take several minutes to download and unzip all of the DEM files. When the process has completed, a notification window will appear (Figure 6-7) to indicate the files have been downloaded, unzipped, and saved. Click **OK**.

Figure 6-7: DEM Downloaded, Unzipped, and Saved



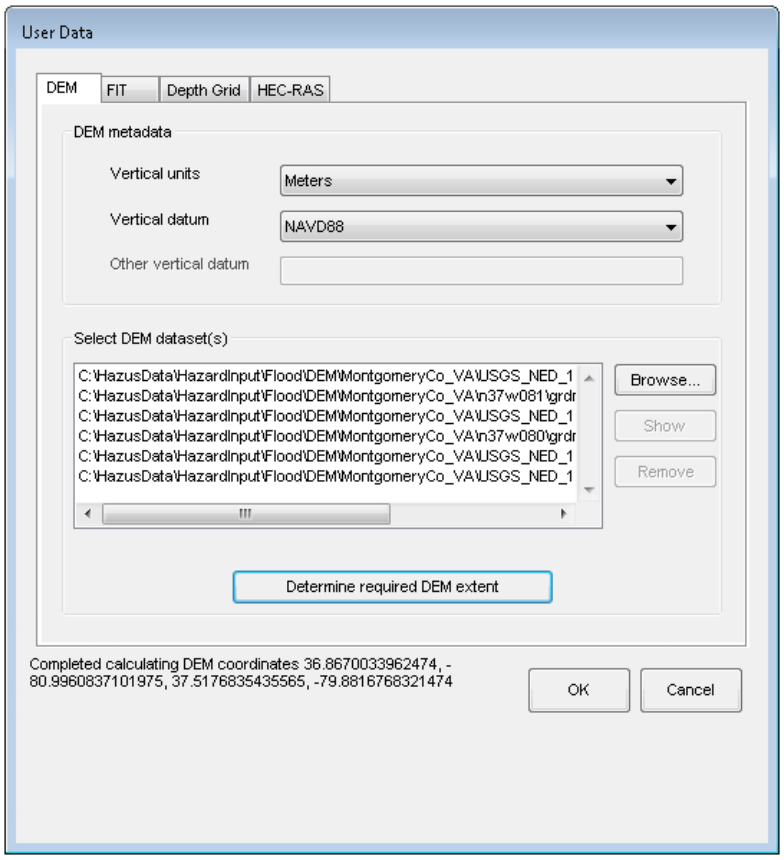
A popup window (Figure 6-8) will ask the user whether to automatically load the DEM data into the **User Data** window. Click **Yes**.

Figure 6-8: Automatically Load DEM



Hazus will load the file paths for all of the DEM files into the **User Data** window (Figure 6-9).

Figure 6-9: Import DEM Files into Hazus



Click **OK** to complete importing the DEM files. Click **Yes** (not shown) on the next popup window to proceed with DEM analysis.

A progress bar (Figure 6-10) will appear as Hazus imports and merges all the individual files into a single DEM for the Study Region. This may take several minutes depending on the size of the Study Region. A notification (Figure 6-11) will appear once the DEM import is completed. Click **OK**.

Figure 6-10: DEM Import Progress

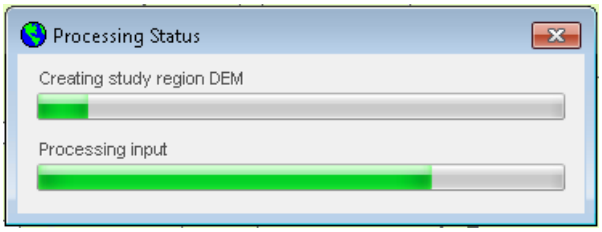
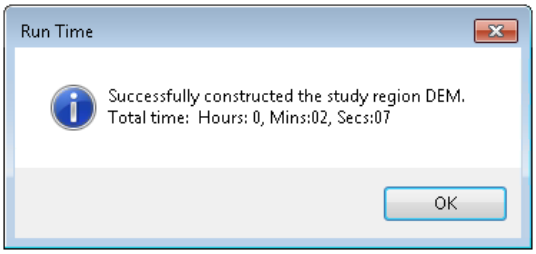


Figure 6-11: DEM Import Completed



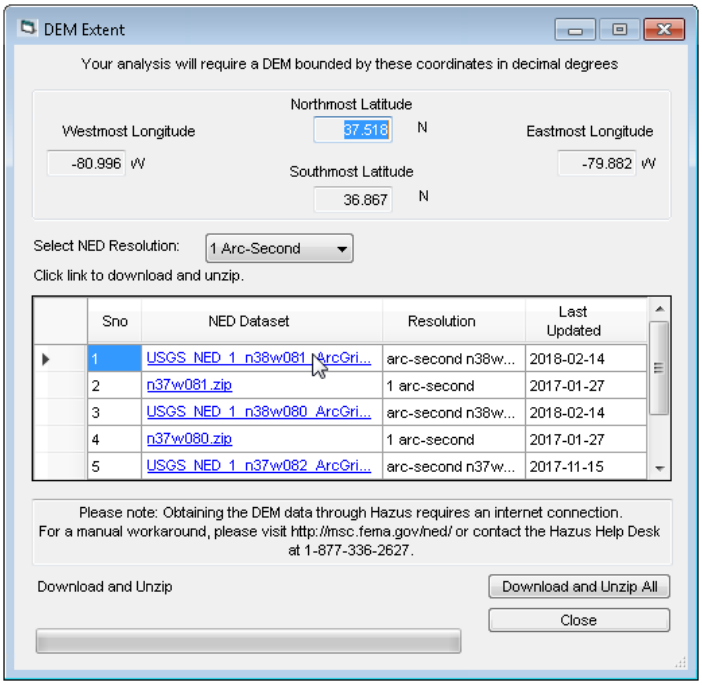
6.2.2 Manual DEM Download

An alternative way to download DEM data is to manually download each DEM file through the **NED Dataset** link (in blue) in the **DEM Extent** window as shown on Figure 6-12. Click on the link for each file and proceed to download the DEM data. The data will be stored in the form of a zip file, which must be unzipped. Any WinZip compatible program (WinZip, WinRar, 7-Zip, etc.) should be able to unzip the data. For large areas, users will be given the DEM in multiple zip files.

Also note the following:

- If pop-up blockers are enabled on the computer, they should be disabled before the DEM is downloaded.
- The DEM data from the USGS is in meters.
- When unzipping multiple zip files, unzip each file to a new folder location. Each ArcGIS grid has some identical file names that will be over-written if the files are unzipped into only one folder.

Figure 6-12: Manual DEM Download



Once all DEM files have been downloaded and unzipped, click **Close** on the **DEM Extent** window to return to the **User Data** window. Click **Browse** (Figure 6-13) and navigate to each downloaded ArcGIS grid directory (Figure 6-14). Highlight the filename and click **Select** as shown in Figure 6-15. Repeat this process until all grids have been added to the **User Data** window (Figure 6-16).

Figure 6-13: Manually Select DEM File

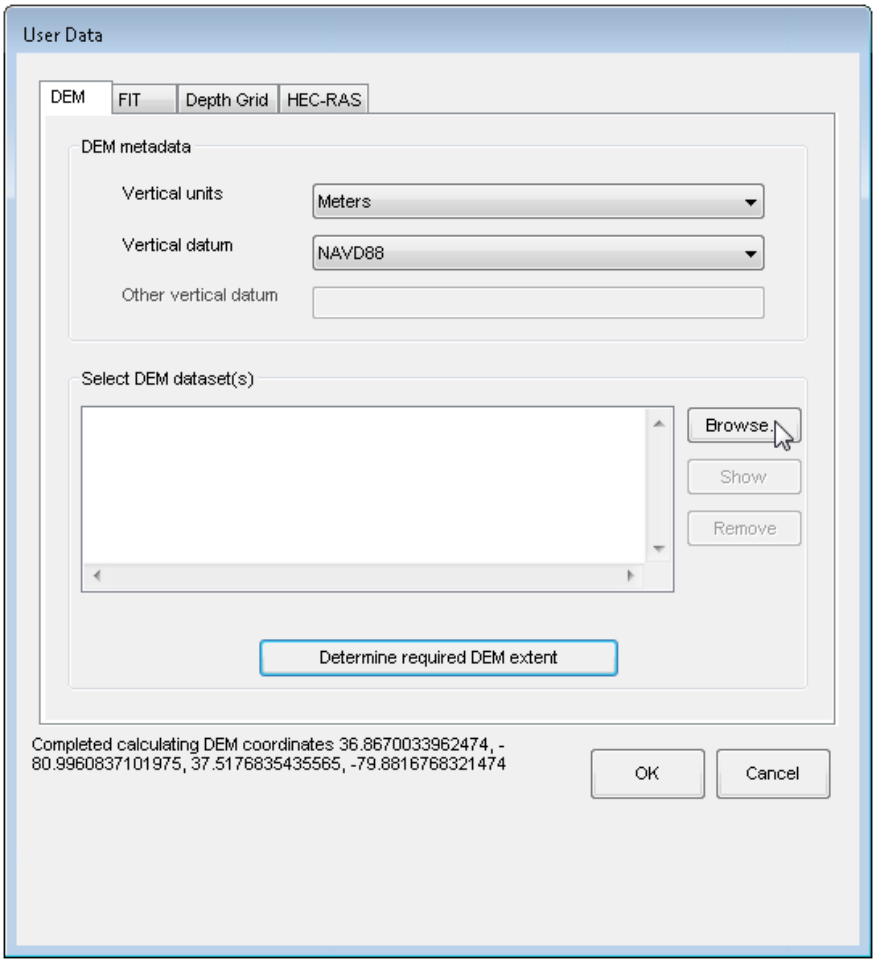


Figure 6-14: Navigate to Directory with Unzipped DEM Files

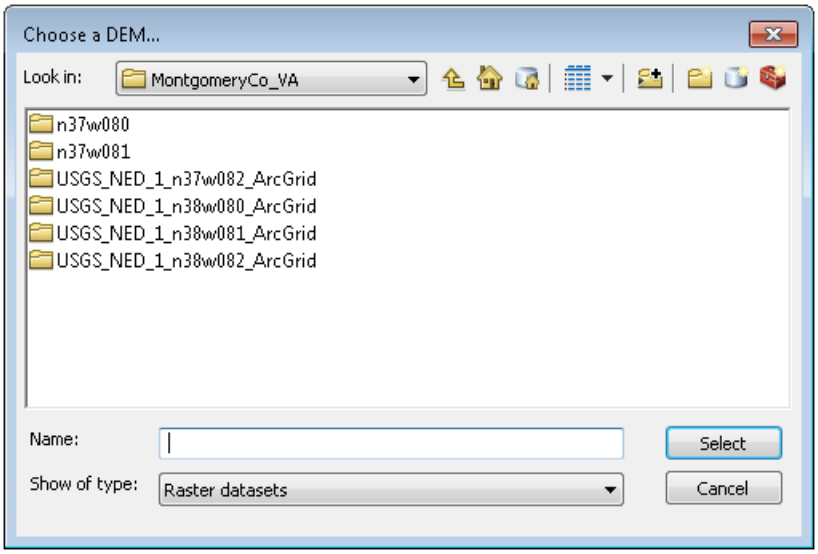


Figure 6-15: Select DEM File

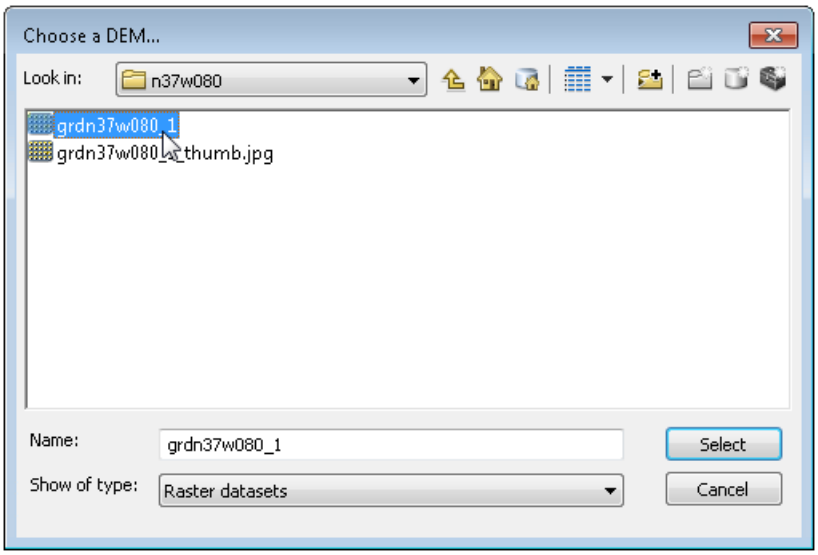
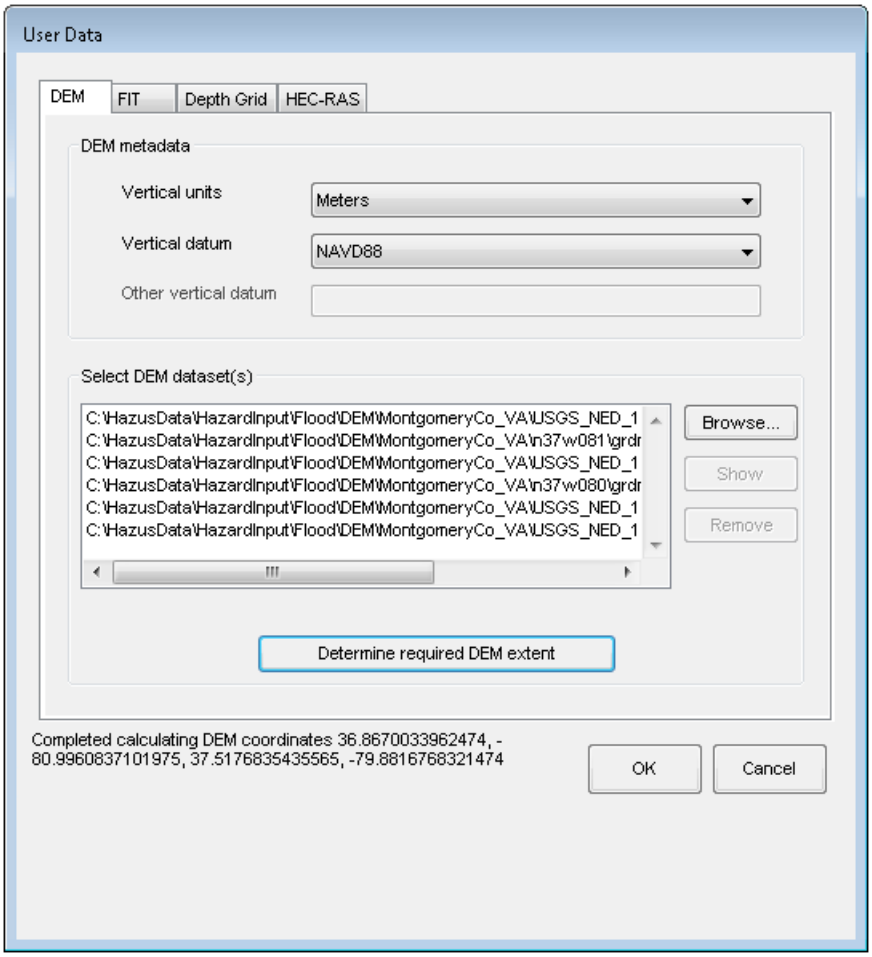


Figure 6-16: Import DEM Files into Hazus



Click **OK** to complete importing the DEM files. Click **Yes** (not shown) on the next popup window to proceed with DEM analysis.

A progress bar (Figure 6-17) will appear as Hazus imports and merges all the individual files into a single DEM for the Study Region. This may take several minutes depending on the size of the Study Region. A notification (Figure 6-18) will appear once the DEM import is completed. Click **OK**.

Figure 6-17: DEM Import Progress

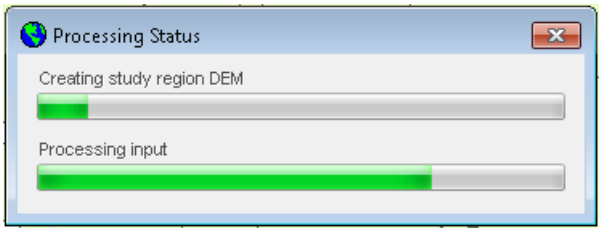
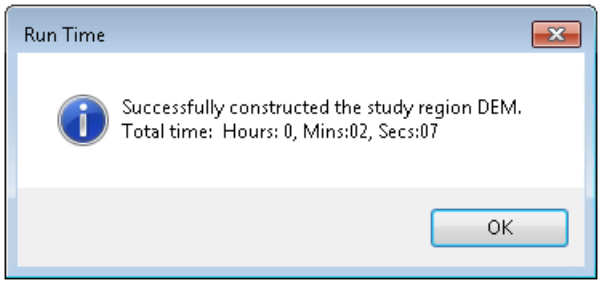


Figure 6-18: DEM Import Completed



6.3 Develop Stream Network

If the Study Region is subject to riverine flood hazard, the next step is to generate a stream network. This is not required if the user is only running scenarios with the recommended user-supplied flood hazard data (Flood Information Tool [FIT], depth grids, floating-point binary [.FLT] grids). Generating a stream network is a one-time analysis that establishes the river network identity for all subsequent scenarios.

The **Develop Stream Network** selection on the **Hazus** menu (Figure 6-19) activates the **Develop Stream Network** dialog shown in Figure 6-20. Enter the number of square miles that define the stream drainage area for the Study Region.

Figure 6-19: Select Develop Stream Network

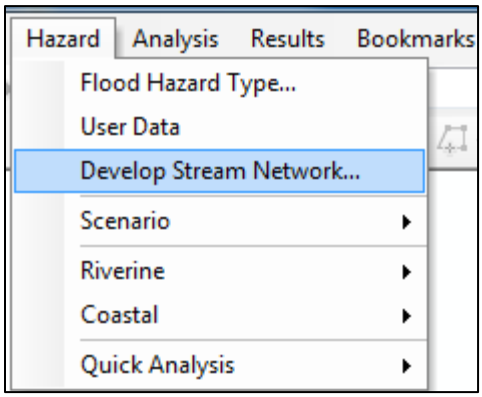
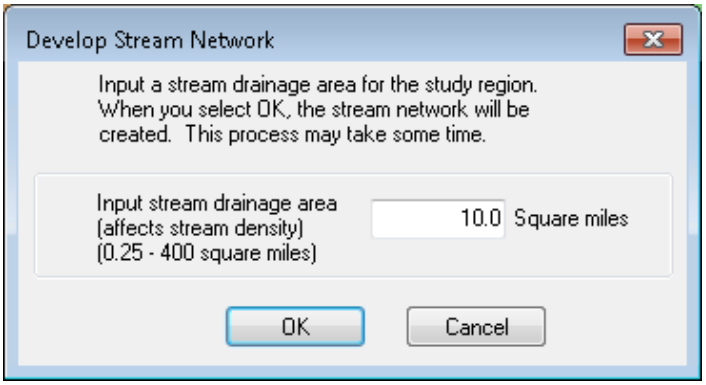


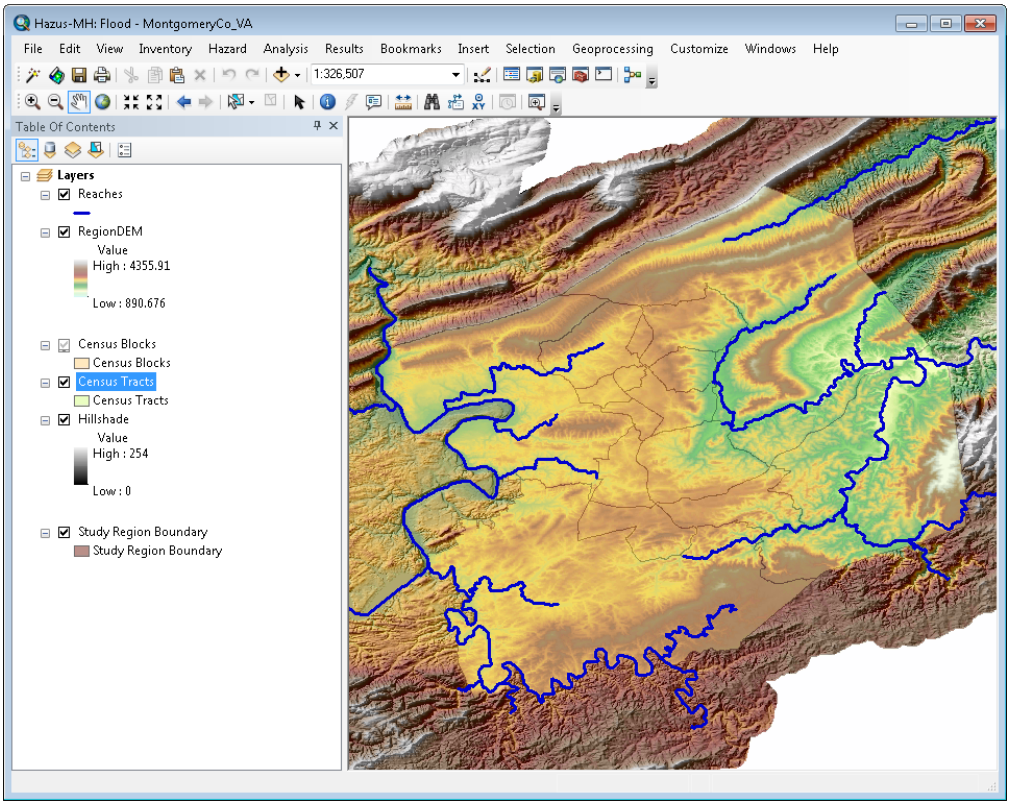
Figure 6-20: Develop Stream Network Dialog



The model will process the DEM for the Study Region to determine the locations of streams. This analysis will take some time, ranging from 5 minutes to several hours, depending on the computer's processing speed, the size of the Study Region, and the complexity of the DEM. When the process is complete, the identified streams will appear on the Study Region, similar to Figure 6-21.

- Selecting a small number of square miles, such as 1, for the drainage area will result in a highly defined stream network. This value represents the total land area, in square miles, that drains into any given reach, excluding that drainage at the starting node of the reach (the downstream node from the prior reach). The smaller the drainage area, the more processing time required by the Flood Model for subsequent analyses.

Figure 6-21: Example – Flood Model after Developing Stream Network



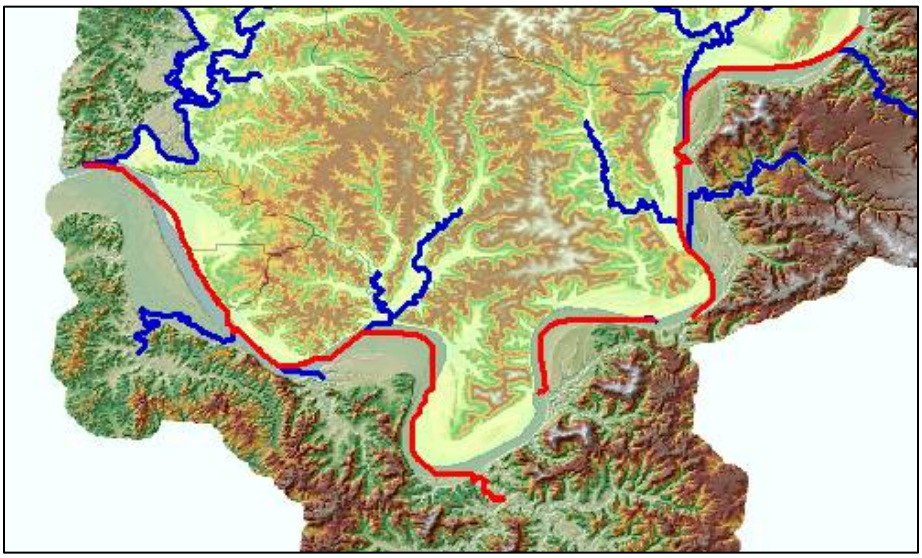
- Running the stream network the first time is fairly time consuming as the model performs an analysis to fill in spurious sinks in the DEM. However, to save the user time for subsequent runs, the model saves the results of the sink-filling process. As such, if the user decides to change the drainage area number, the model will not require nearly as much time to perform the analysis. For example, if the user runs the stream network at 5 square miles and then decides that the network requires more detail, changing the drainage area to 1 square mile will process significantly faster than the original analysis. Please note that Hazus must still re-calculate and assign the Manning's-n coefficient, associated with stream roughness, to each reach. This process will appear to the user as "Finalizing Stream Network" and will take additional processing time if the user changes the **drainage area** value.

If a river in the analysis forms a border between two counties, including both counties on either sides of the river in the Study Region is recommended. The stream network in Hazus is known as a synthetic network because it is derived entirely from the DEM. No imagery or pre-existing map layers are used in its generation. More specifically, streams in a synthetic network exist at DEM grid cell locations that receive drainage from a threshold number of upstream grid cells. If the DEM is not large enough, the threshold number of grid cells may not be reached.

Figure 6-22 shows an example of this situation with a discontinuous synthetic stream. The Study Region consists of one county, for which the one river (displayed in red) forms a border. Because the DEM does not include areas draining to both sides of the river, the resulting

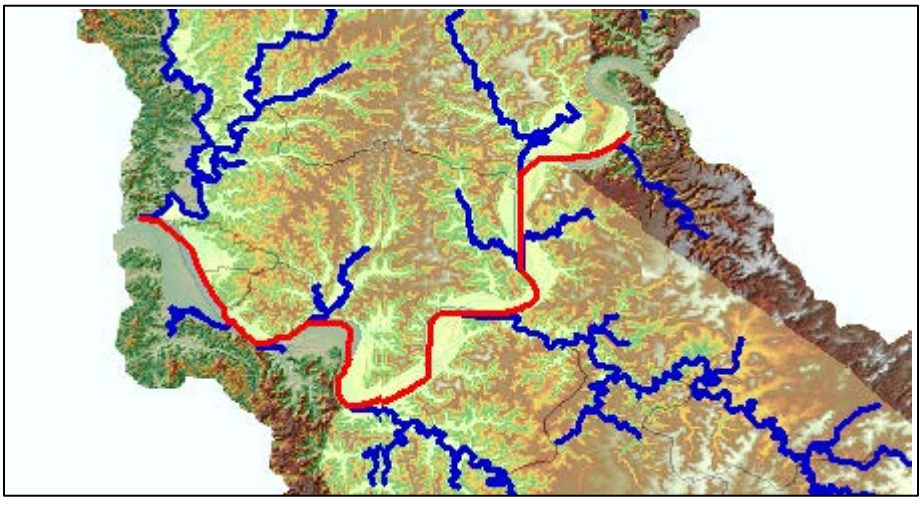
synthetic stream is discontinuous. There are simply not enough DEM grid cells draining to the discontinuous portions to properly delineate them.

Figure 6-22: Example Discontinuous Synthetic Stream



The solution to this discontinuity problem is to include counties on both sides of the river during Study Region creation. Including both counties will result in a larger DEM that drains to both sides of the river. Figure 6-23 illustrates this concept using the same stream as shown in Figure 6-22. The second Study Region consists of counties on either side of the river (shown in red) and the resulting synthetic stream network is now continuous.

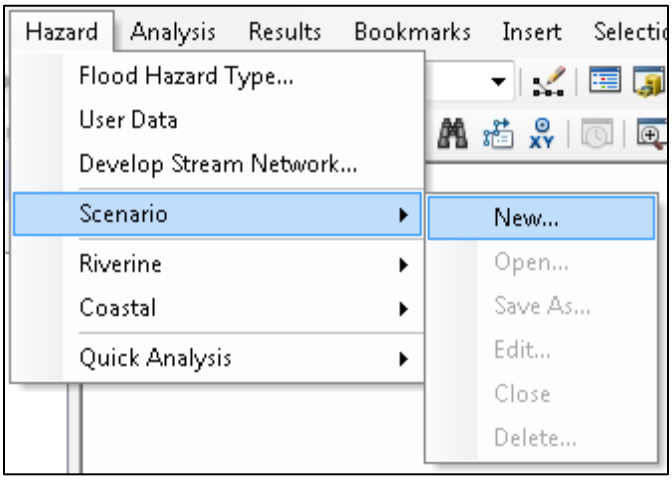
Figure 6-23: Example Continuous Synthetic Stream



6.4 Scenario

A scenario defines the specific stream reaches, or lengths of coastline for coastal users, and the hydrologic and hydraulic characteristics to be included in one analysis run. A scenario could include all stream reaches in the Study Region, and/or the coastline in a coastal Study Region. However, because the analysis requires significant computer processing, dividing the region into several smaller scenarios may be preferable. Figure 6-24 shows the **Hazard** / **Scenario** menu with only the **New** selection active prior to defining the first scenario for a Study Region. Figure 6-25 shows the **Hazard / Scenario** menu with all selections active after the initial scenario has been defined.

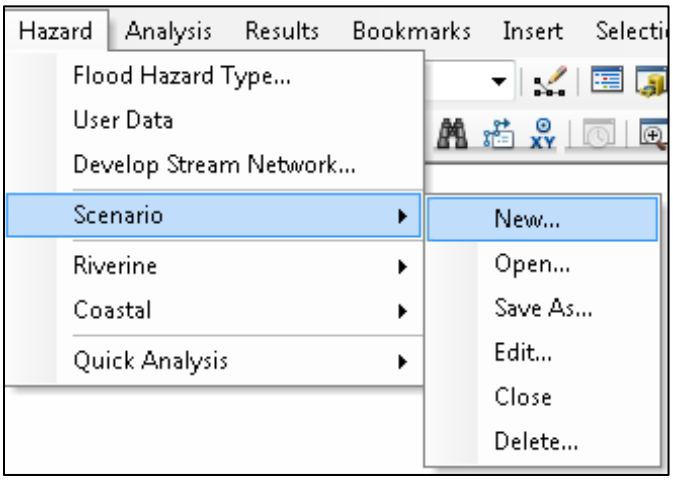
Figure 6-24: Select New Scenario (Prior to Defining First Scenario)



6.4.1 New

Under the **Scenario** menu option, select **New,** as shown in Figure 6-25, to create a new scenario. The process of defining a new scenario for riverine, coastal, and combined analyses each require different steps. These steps are detailed in the next sections.

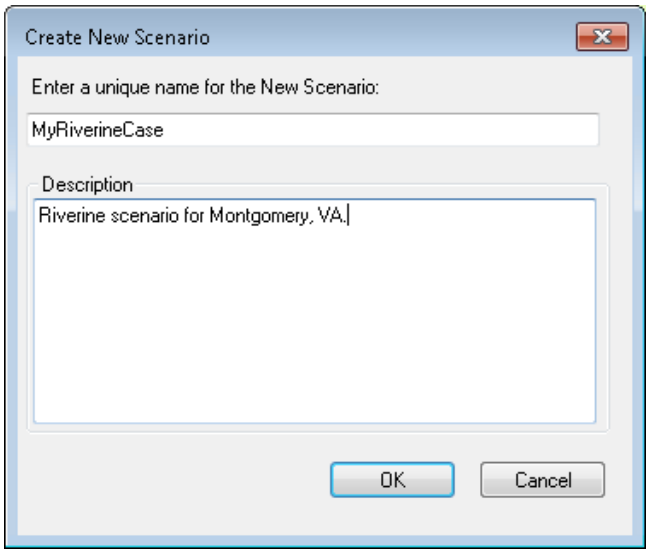
Figure 6-25: Select New Scenario (After Defining First Scenario)



6.4.1.1 Riverine Scenario

The **Create New Scenario** window, shown in Figure 6-26, will appear. Enter a name for the scenario and an optional description. Be careful not to include any leading or trailing spaces. The **Description** will be visible to the user when opening scenarios in the future to help differentiate between similarly named scenarios.

Figure 6-26: Enter a Name for the New Scenario



After naming the scenario, the **New Scenario** window (Figure 6-27) will open, allowing the user to select which stream reaches to include in the scenario. Click the radio button next to the appropriate **Map layer type**. To select features, click the **Add to selection** (**+**) button, then drag the selection box around the features to be selected to add reaches to the scenario and then click **Save selection** (the floppy disk icon). The **Remove from selection** (**−**) button removes reaches from the selected reaches. Similarly, the **Clear selection** (✕) button clears all reaches from the selection.

The selected features will be highlighted in a light blue color, as shown in Figure 6-28. After saving the selected stream reaches, click **OK** to complete the definition of the scenario. The color of the selected reaches changes from light blue to red when this process is complete.

Figure 6-27: Select Map Features

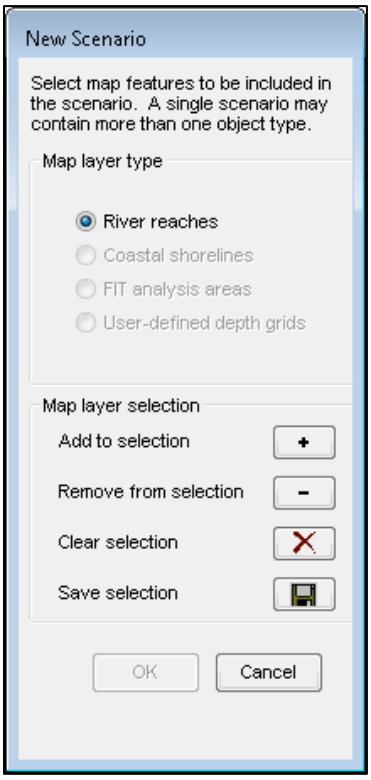
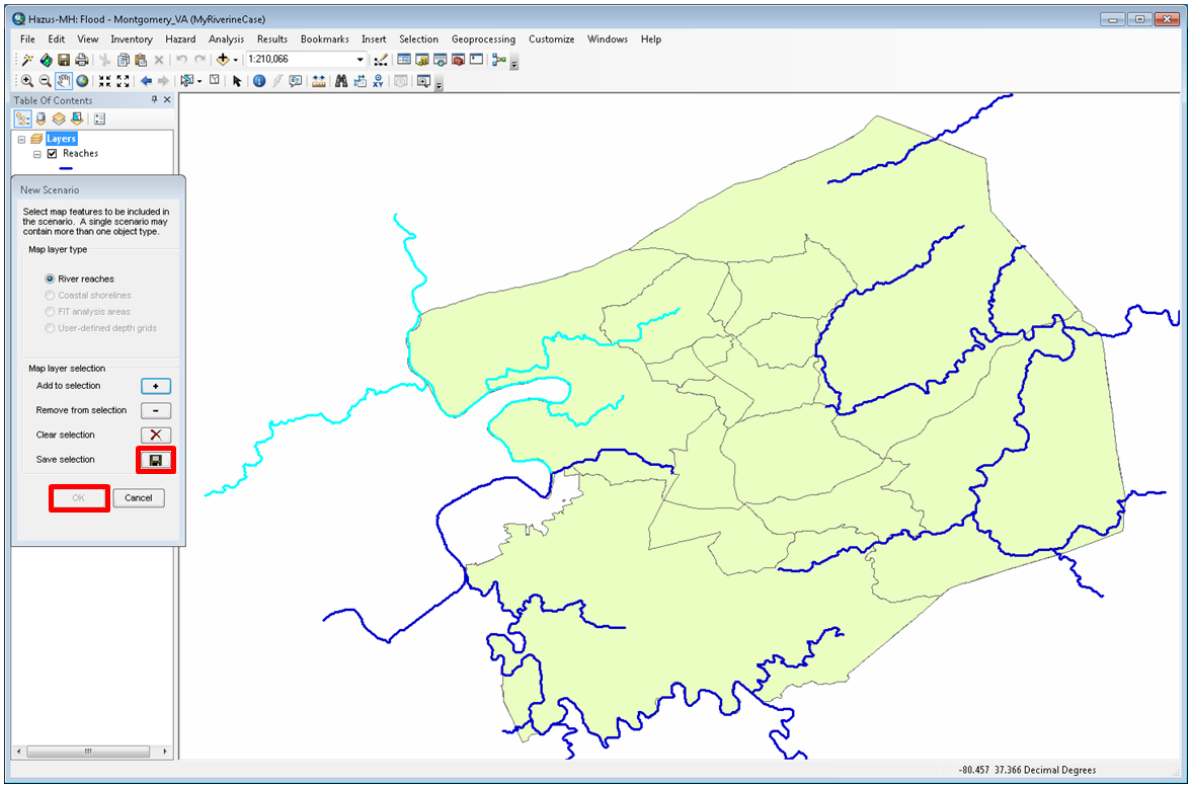


Figure 6-28: Select River Reaches for a Scenario

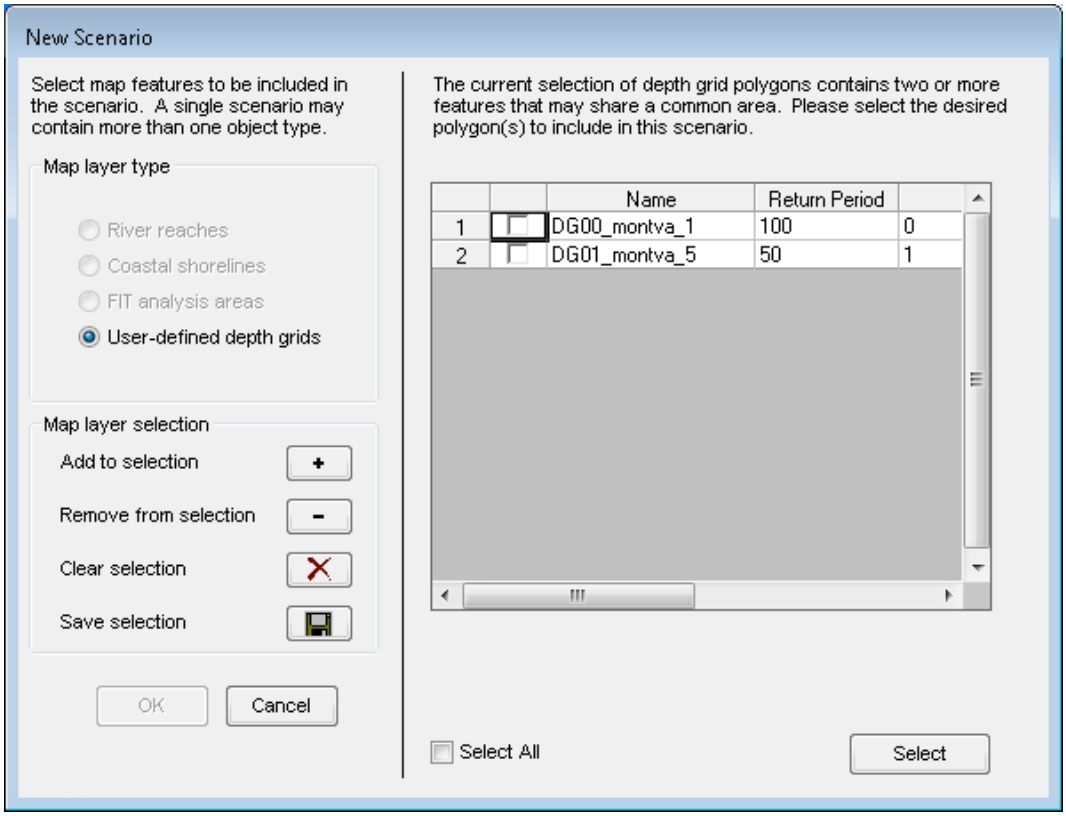


- After selecting the features in the map layer, users must click **Save selection** for each specific map layer type. For example, if a user wants to create a scenario with river reaches, coastal shorelines, and FIT analysis areas, the user must: 1. Select the **River reaches** radio button, click the **Add to selection** button, select reach(es), click the **Save selection** button. 2. Select the **Coastal shorelines** radio button, click the **Add to selection** button, select shoreline(s), click the **Save selection** button. 3. Select the **FIT analysis areas** radio button, click the **Add to selection** button, select FIT area(s), click the **Save selection** button. Click **OK**.

If the user has imported any FIT data and/or flood depth grid(s), those areas can be selected by clicking on the **FIT analysis areas** and/or the **User-defined depth grids** radio buttons. Select and save FIT areas and/or flood depth grids in the same manner as the reach selection.

If more than one flood depth grid is selected for the scenario, the dialog will expand to show the list of selected flood depth grids selections, as shown in Figure 6-29. Users can select one or more depth grids for the scenario.

Figure 6-29: Select User-Defined Depth Grids for a Scenario



6.4.1.2 Coastal Scenario

Coastal analysis does not require the user to generate a stream network or run the hydrologic analysis. However, the user will still be required to obtain and identify the DEM to be used in the analysis. The extent of the DEM necessary for the coastal flood hazard is different from that required for the riverine flood hazard. The necessary DEM is determined by the union of the region shoreline with the Study Region boundary.

Once the DEM has been added, the user can move directly to defining a scenario by selecting **New** from the **Hazard / Scenario** menu. The **Create New Scenario** window will appear (Figure 6-30). As with the riverine analysis, enter a name and, if desired, a description for the scenario, and click **OK**. The window shown in Figure 6-31 will appear.

Figure 6-30: Enter a New Scenario (Coastal)

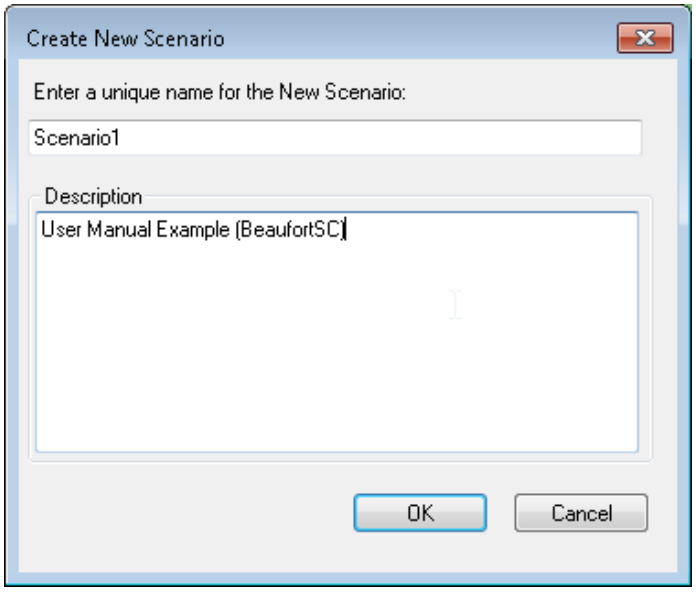
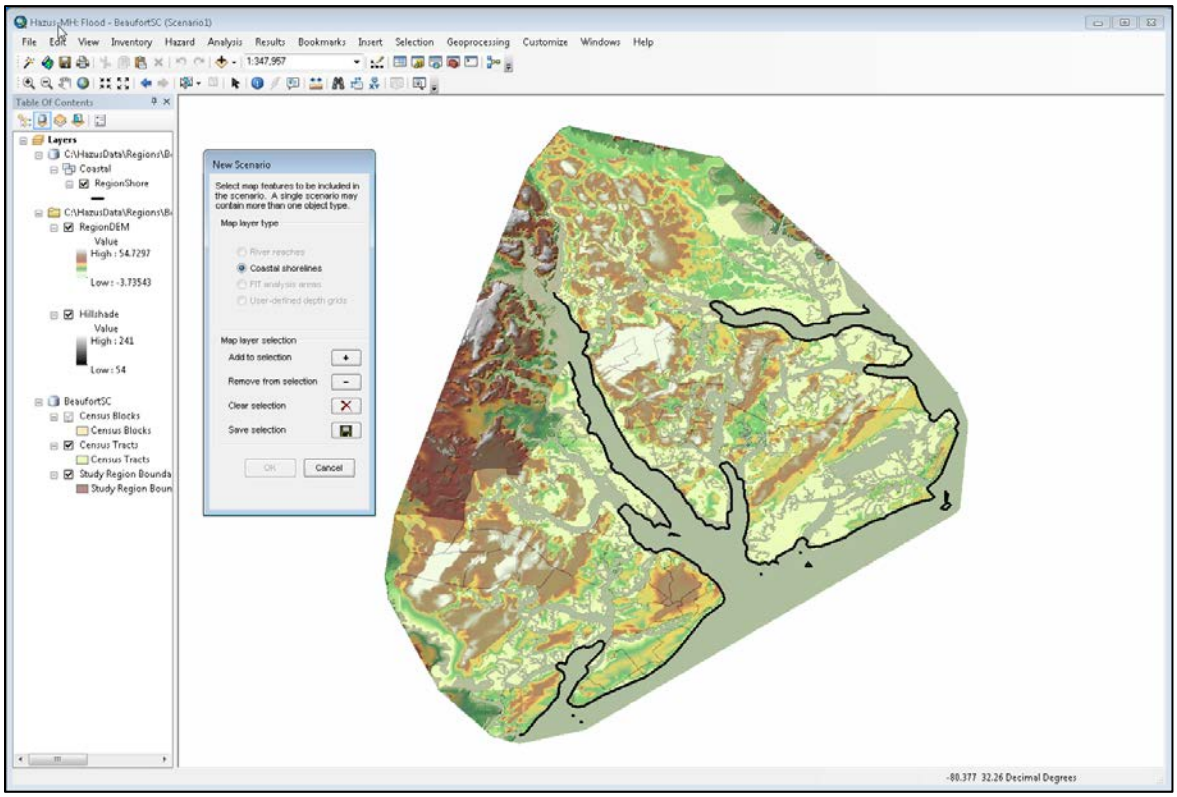
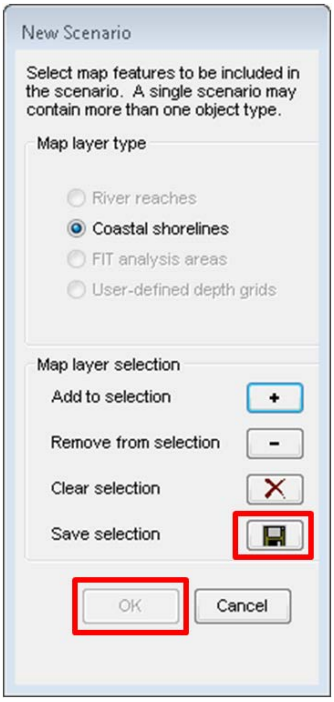


Figure 6-31: Select a Shoreline for a New Coastal Scenario



Similar to the riverine hazard, the user will be asked to select a shoreline or shorelines for analysis (Figure 6-31). Click the radio button next to the appropriate **Map layer type** (Figure 6-32**)**. The Flood Model uses a standard GIS selection tool to allow the user to select the shorelines. Click the **Add to selection** (**+**) button, then either click on the shoreline or draw a box to select more than one shoreline.

Figure 6-32: Select Shoreline



- To select discontinuous shorelines, such as islands, press the **Shift** key while selecting additional shorelines. To deselect shorelines, press the **Shift** key and click on the shorelines that are not to be included in the selected shorelines.
- Hazus has a built-in default national shoreline that is delineated by county. In Study Regions that are sub-county or a combination of multiple sub-counties, all of the associated shorelines of the counties will be brought in. This is by design to account for coastal flooding at specific locations that does not necessarily originate from the closest shorelines to those locations.
- The Flood Model has shorelines for mainland areas, barrier islands, large islands, small islands, and the Great Lakes. These shorelines have been smoothed to allow the Flood Model to build shore normal transects in a less time-consuming fashion.

Once the shorelines have been selected, click the **Save Selection** button (the floppy disk icon); the **OK** button will become enabled (Figure 6-32). Click **OK**. This completes the process of creating the new scenario and selecting shorelines. The next step in the process is to characterize the chosen shorelines.

The **Shoreline Limits** dialog (Figure 6-33) will automatically pop up after shorelines are selected for the scenario to characterize the limits of the shoreline. This dialog begins the process in which the user identifies where they wish to start characterizing the shoreline (**Shoreline Start**) and where they would like to finish the characterization (**Shoreline End**) as shown on the interactive map layer (Figure 6-34). In between these two points, the user will want to add any breaks in the shoreline (**Breaklines**) where the geographic characteristics of

the shoreline change. The Flood Model will develop transects at 1,000-foot increments and perform the analysis (e.g., simplified Wave Height Analysis for Flood Insurance Studies [WHAFIS]) only between the **Shoreline Start** and **Shoreline End** lines. If the default locations (at the end of each segment) are moved, the Flood Model will limit the development of transects between these locations.

- The Flood Model will develop transects and perform a simplified WHAFIS and runup analysis between the **Shoreline Start** and **Shoreline End** lines—either the default locations or those generated by the user. The Flood Model will still develop a stillwater elevation (SWEL) surface over the entire Study Region to ensure that flooding through other low-lying areas is properly accounted for.

The **Shoreline Limits** dialog allows the user to perform the segmentation of the shoreline if necessary (Figure 6-33). Figure 6-34 shows the interactive map layer.

Figure 6-33: Input Shoreline Limits

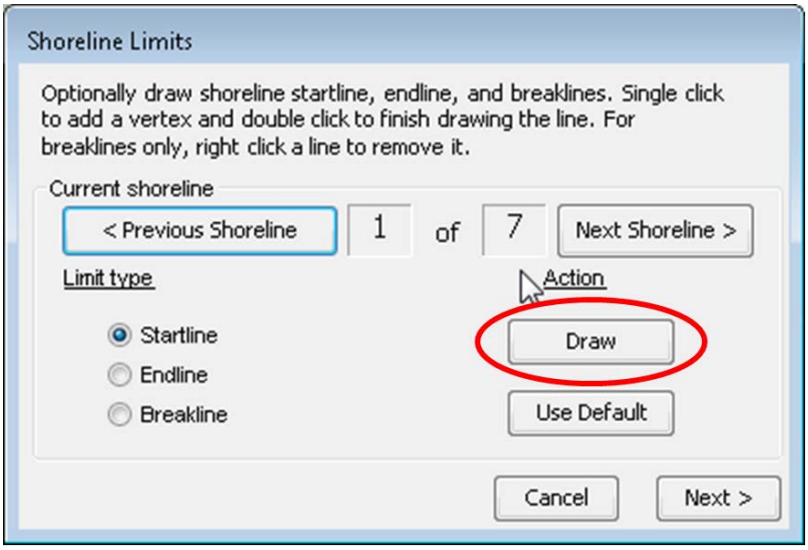
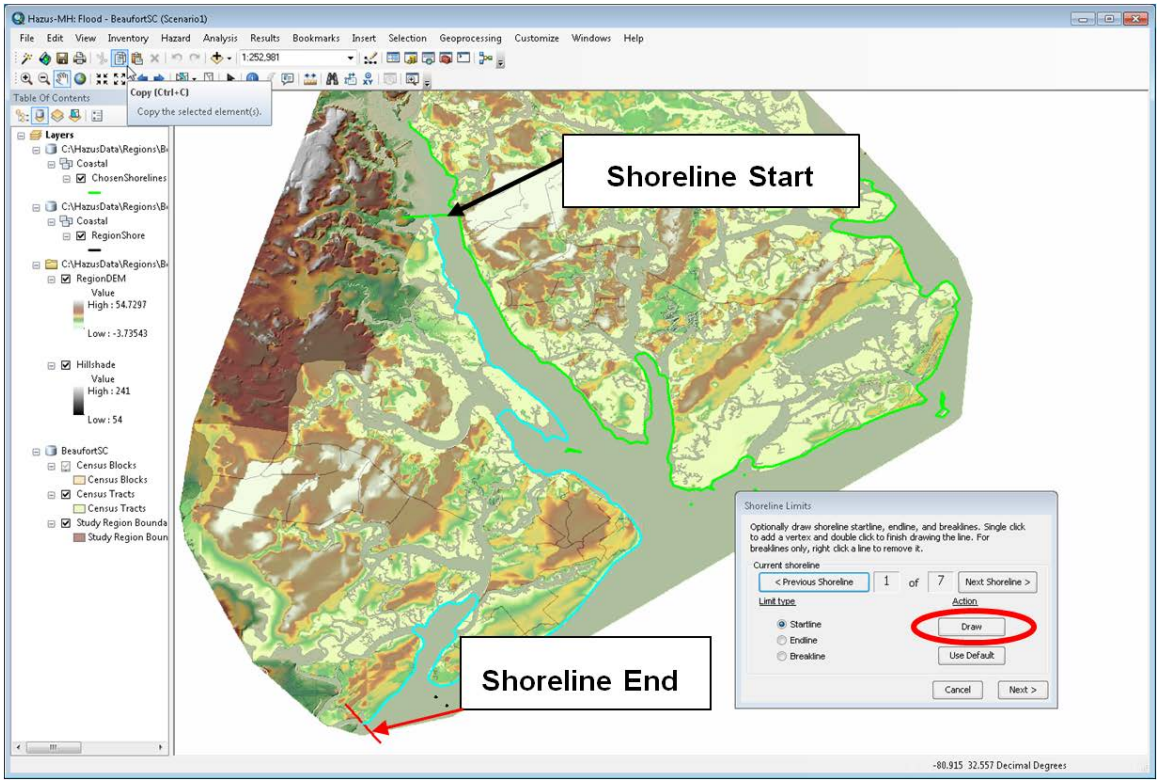


Figure 6-34: Example – Setting Shoreline Limits



The user can leave the shoreline start and end as shown in Figure 6-34 or change the limit(s) (**Startline** or **Endline**) and click the **Draw** button (circled) to draw a new line on the map. The model will remove the default line and replace it with the newly drawn line. For example, Figure 6-35 shows what the user might see upon changing the **Shoreline Start** point (**Startline**).

- The user must be sure to draw the line so that it crosses the shoreline only once. This could be from inland into the flood source or from the flood source inland. The Flood Model will automatically make the line shore normal or perpendicular to the shoreline.
- Hazus allows users to zoom in or out of the map before clicking on the **Draw** button. After clicking the **Draw** button, the tool is set to the Line tool, and the customization becomes locked; therefore, users will not be able to select any other tool until the **Startline**, **Endline**, and **Breakline**(s) are drawn.

The user can move the **Startline** if the initial effort is not in the right location by merely reselecting the **Draw** button and drawing the **Startline** in another location. Similarly, if the user decides not to change the **Startline** after having drawn one, the user can click on the **Use Default** button and restore the **Startline** to its default location.

- Clicking on the **Use Default** button (see Figure 6-35) will only restore the active **Limit type**, such as the **Startline** or the **Endline**. To restore both the **Startline** and the **Endline**, the user needs to select the appropriate radio button and click on the **Use Default** button for each line.

Figure 6-35: Example – Resetting the Shoreline Startline

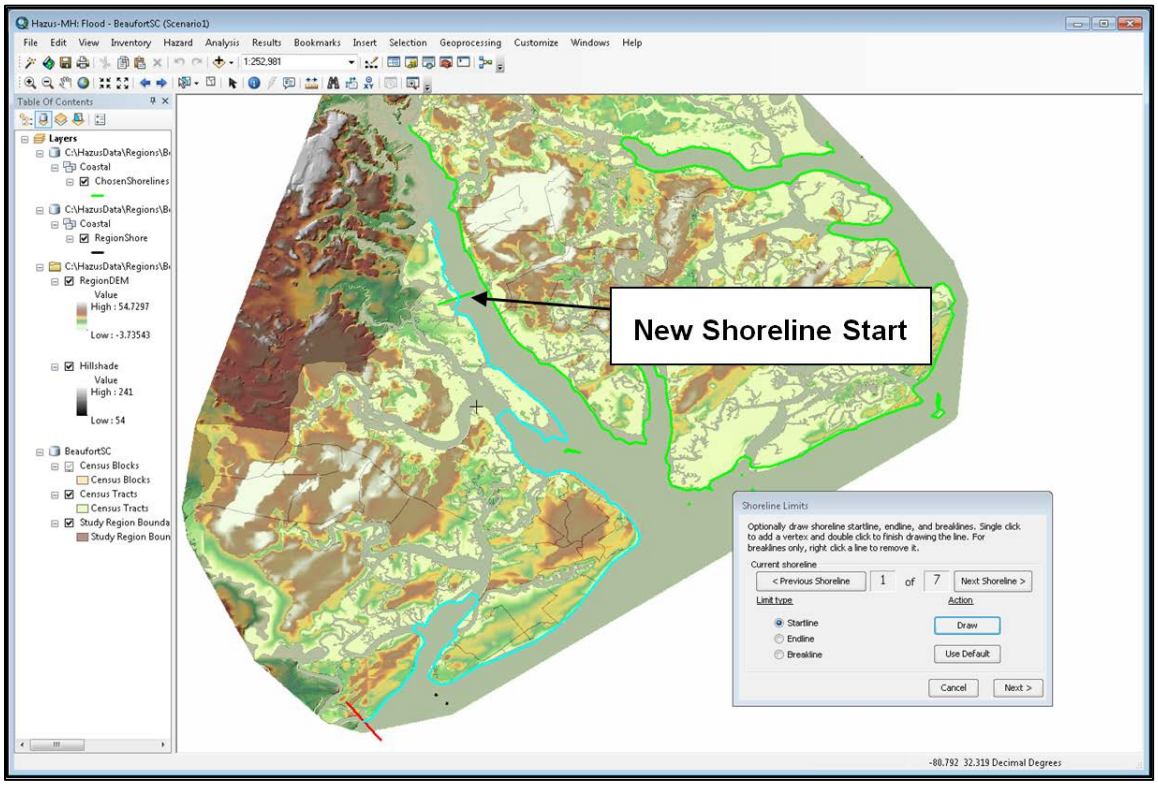
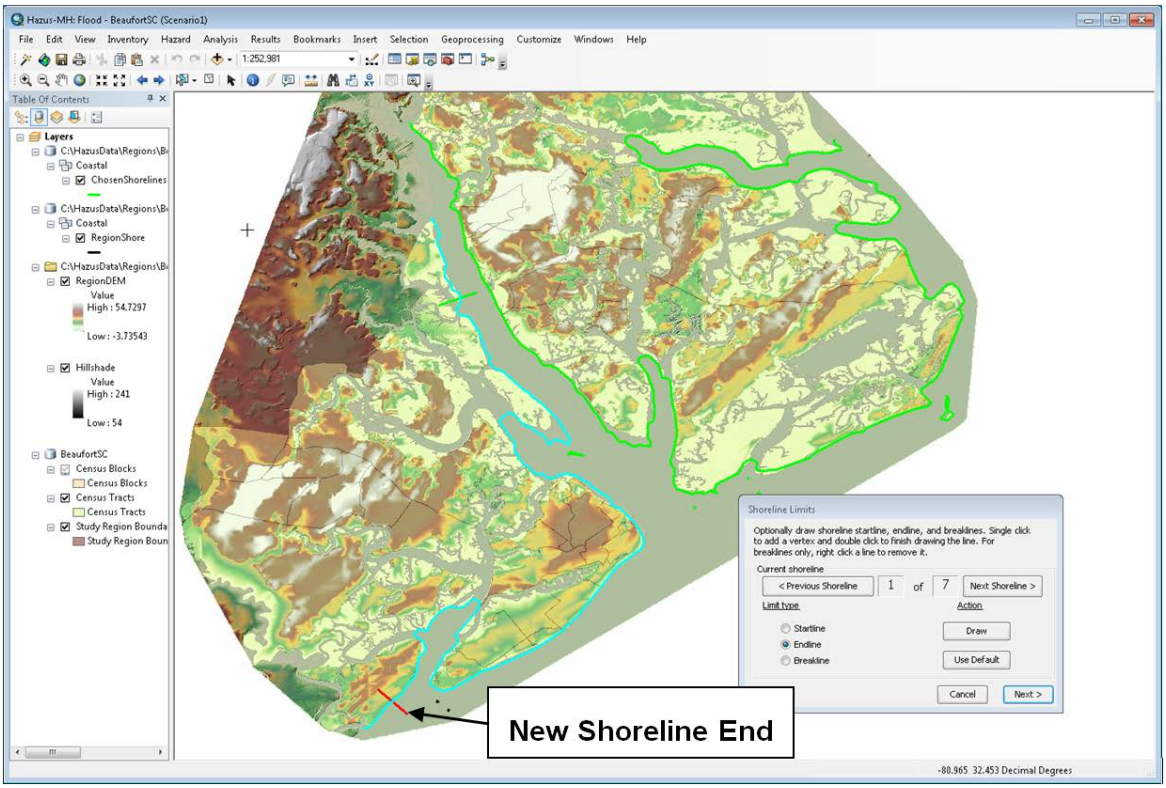


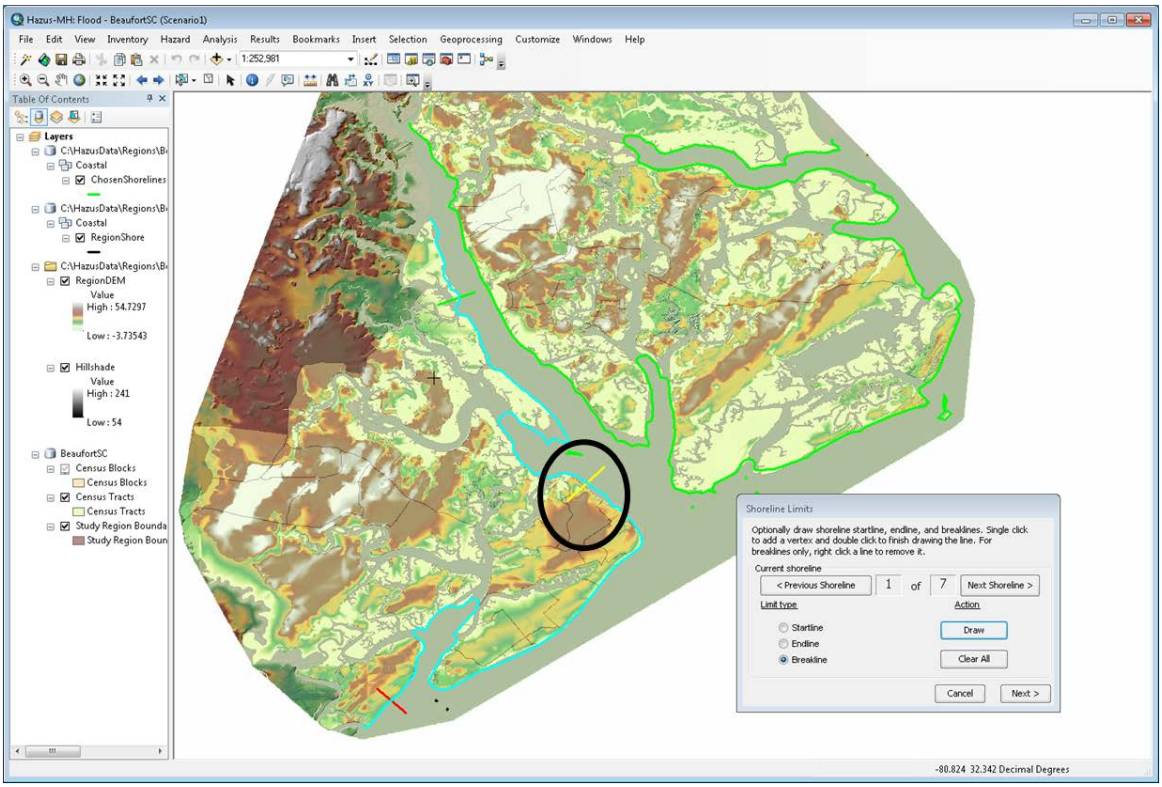
Figure 6-36 shows an example of a changed **Shoreline End** (**Endline**). Similar to the **Startline**, the user can change the location of the **Endline** by clicking on the **Draw** button and drawing a new line. To restore the **Endline** to its default location, click on the **Use Default** button with the **Endline** radio button enabled.

Figure 6-36: Example – Resetting the Shoreline Endline



As stated previously, if the Study Region geography changes along the shoreline, the user will want to segment the shoreline and classify the shoreline into the proper geophysical properties. Consult a Flood Insurance Study (FIS), identify the areas along the shoreline where the SWEL changes, and create a **Breakline** at these points. Select the **Breakline** radio button and click **Draw**. As with the **Startline** and the **Endline** drawing, draw a line crossing the shoreline only once as circled in Figure 6-37.

Figure 6-37: Example – Adding a Breakline to the Selected Shoreline



- The user cannot change or move a **Breakline** once it has been drawn; to remove the line, clear the **Breakline** using the **Clear All** button and redraw the **Breakline** in the new location.

After all breaklines have been drawn, click **Next** to open the **Shoreline Characteristics** window shown in Figure 6-38. The information for this window can be obtained from a FEMA FIS. Check the FEMA website for information on obtaining an effective FIS for the Study Region.

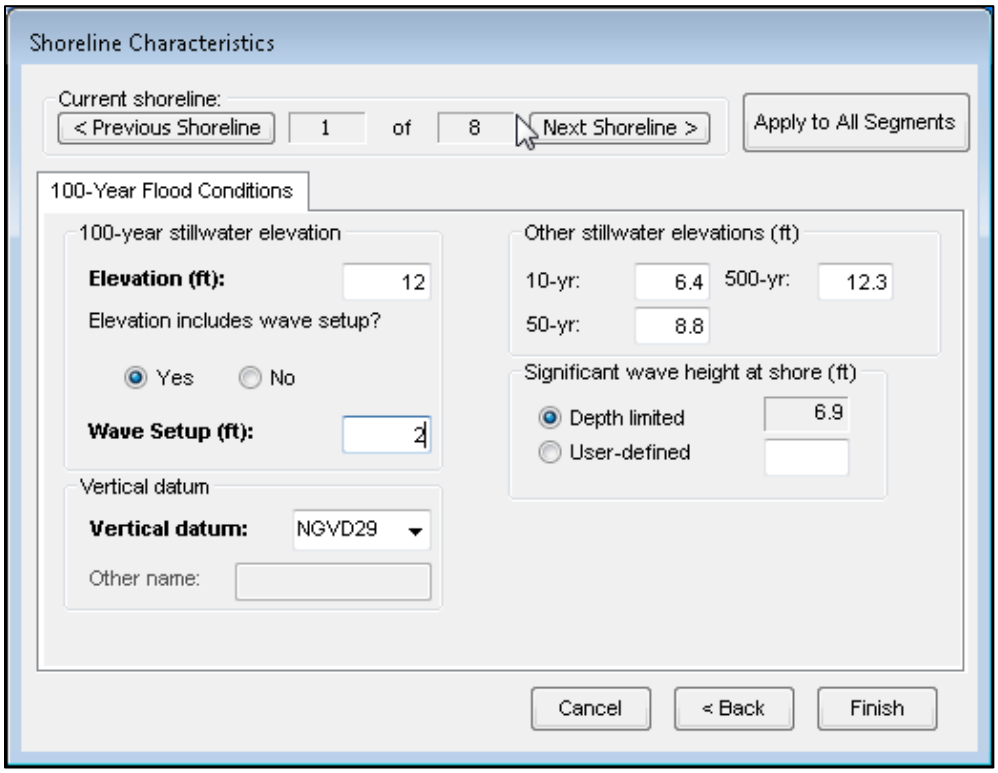
Input the SWEL in the **Elevation** field shown in the **Shoreline Characteristics** window (Figure 6-38). This field and the **Vertical Datum** field are required and will be shown in red text. The other SWEL fields are loaded with default parameters calculated using the standard FEMA ratios, but can be edited and overwritten by the user if the data are available from the FIS.

- The user should review the FIS carefully to determine whether the 100-year SWEL includes wave setup. If it does, the user should put in the 100-year SWEL as noted in the FIS, but must also check the **Yes** radio button under the **Elevation includes wave setup?** question. Doing this will enable the **Wave Setup (ft)** field. The user should enter

the wave setup value here. If the user cannot identify whether wave setup is included, quickly graph the SWELs listed in the FIS and check whether the 100-year SWEL is higher than expected by the graph. If so, it most likely includes wave setup.

After entering the **Elevation** and **Vertical Datum** for each shoreline segment, click **Finish**.

Figure 6-38: Shoreline Characterization – Stillwater Flood Conditions Window



Once the user has completed inputting the required information in the **Shoreline Characteristics** window, the Flood Model has the necessary data to perform a coastal analysis for any given return interval.

6.4.1.3 Combined Riverine and Coastal Scenario

Hazus asks the user to select between three flood hazard types in the **Flood Hazard Type** dialog (Figure 6-3) to limit the DEM requirements: **Riverine Only**, **Coastal Only**, or **Riverine and Coastal**. Selecting **Riverine and Coastal** will require the user to acquire a DEM that supports the analysis for both hazard types. Once the user provides the DEM, they can perform any of the hazard analyses.

For example, if the user selects **Riverine and Coastal**, they are required to build the **Stream Network** with the shorelines already available. While creating a scenario, the user has the option to build a scenario with only river reaches, only shorelines, or a combination of reaches and shorelines. The Flood Model maintains the riverine and the coastal hazard depth grids

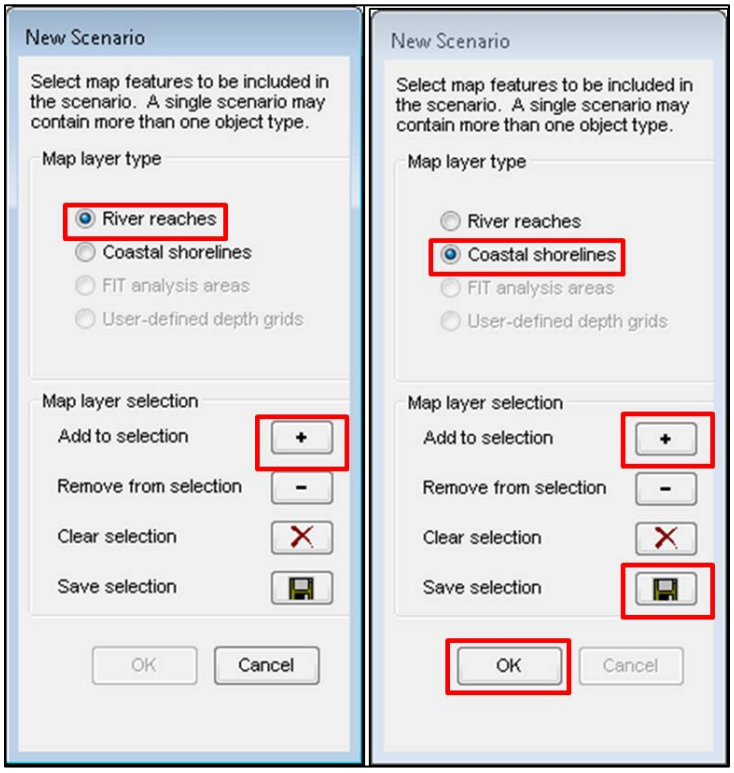
separately, because the depth of flooding alone does not determine which hazard is producing the most damage by occupancy.

Create a riverine and coastal flood hazard analysis within the Study Region. If necessary, first create a new Study Region. Once the Study Region is created, open it, open the **Hazard** dropdown menu and select **Flood Hazard Type**. Choose the **Riverine and Coastal** flood hazard type (Figure 6-3). See Chapter 3 to review how to create a flood Study Region and Chapter 4 for details on opening a Study Region.

If the user chooses to run a scenario with river reaches and coastal shorelines, the Flood Model will analyze the impact of both hazards on the inventory independently. It will then compare the resulting losses to determine which hazard is the controlling hazard (i.e., the hazard that has the greatest impact on that occupancy or structure).

To perform a combined analysis, the user would create a new scenario with both riverine and coastal components. After the **Create New Scenario** window (not shown), select the **River reaches** radio button (Figure 6-39). Then, select reach(es) using the **Add to selection** (**+**) button, and click **Save selection**. Second, select the **Coastal shorelines** radio button (Figure 6-39). Then, select shoreline(s) using the **Add to selection** button, and click **Save selection**. Click **OK** to ensure that both selected layers are saved. For more detailed instructions, refer to the previous sections on creating Riverine and Coastal Scenarios separately.

Figure 6-39: Select River Reaches and Coastal Shorelines



6.4.2 Open

A user may create multiple scenarios for each Study Region. Select **Open** from the **Scenario** menu, as shown in Figure 6-40, to open a previously created scenario. The **Open Scenario** dialog will appear (Figure 6-41). Click on the scenario's name to highlight it, and then click **OK**. Only one scenario can be opened at a time.

Figure 6-40: Select Open Scenario

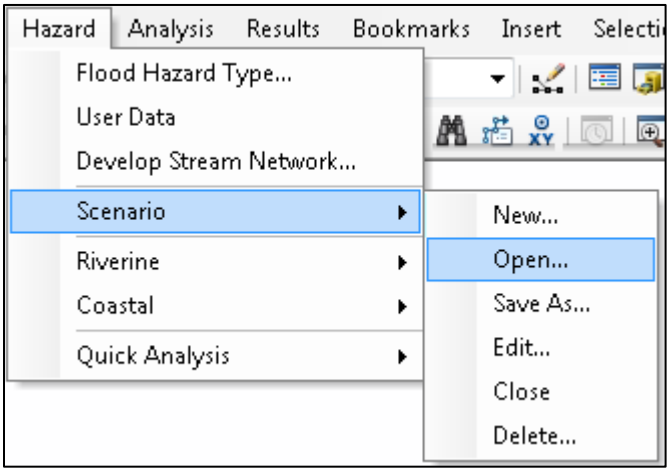
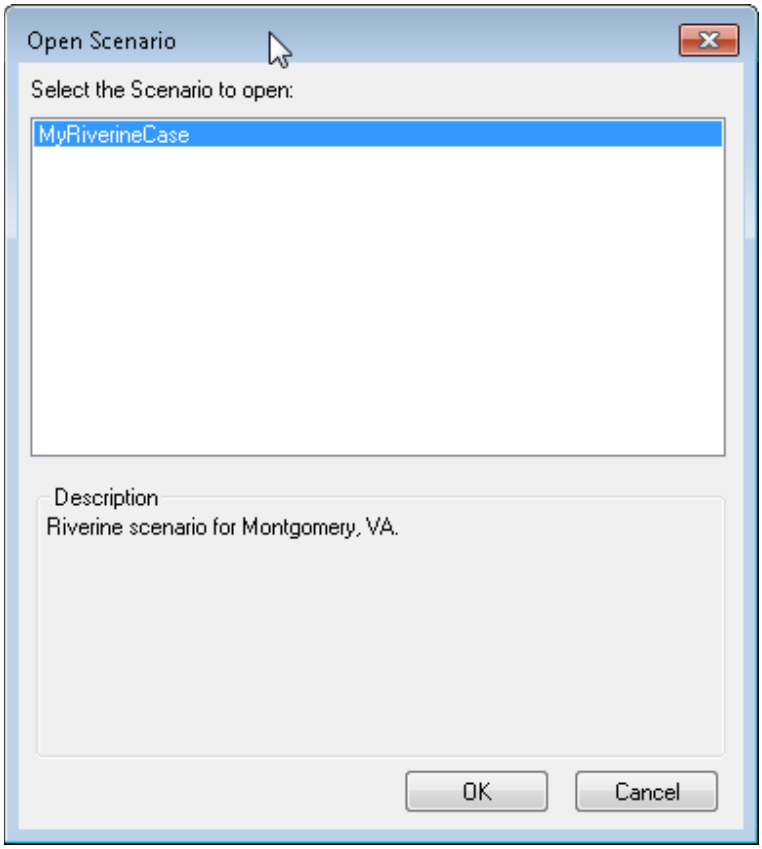


Figure 6-41: Open Scenario Dialog



6.4.3 Save As

The **Save As** option under the **Scenario** menu allows users to skip the hazard analysis every time they want to run different parameters in the **Inventory** or **Analysis** menu. It saves the user time by skipping the hazard selection and rerunning the analysis. It also provides the user a way to preserve previous results without using the **Duplicate Study Region** function, which requires much more disk space. The results tables are scenario-specific and creating a new scenario using the **Save As** function assumes the user wants new results. As such, the old results are not carried over.

In addition to creating a new scenario and opening a scenario, the **Scenario** menu options shown in Figure 6-42 let the user to edit, close, or delete any created scenarios. To use the **Save As** capability, the scenario to be saved must be open. From the **Scenario** menu, select **Save As**. The **Save Scenario As** window, shown in Figure 6-43, will appear. Enter a name for the new scenario and an optional description. Click **OK** to save the old scenario and automatically open the new scenario.

NOTE: Each scenario must have a unique name.

Figure 6-42: Select Save As

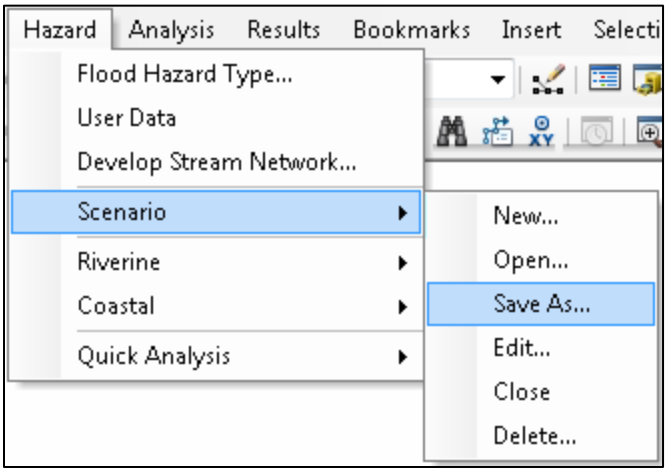
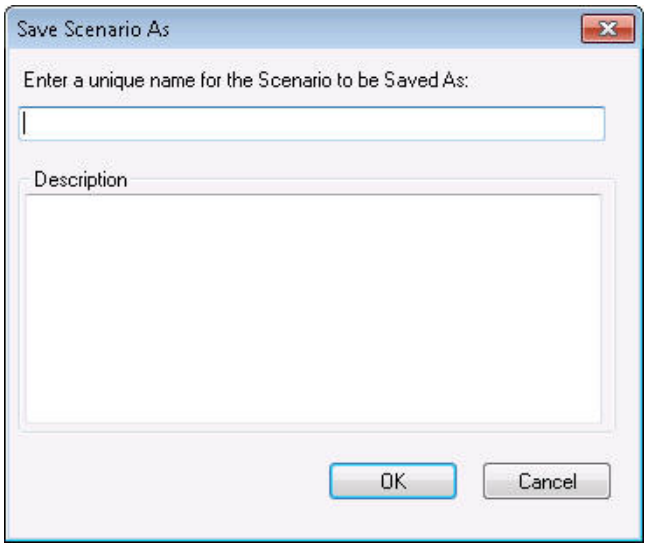


Figure 6-43: Enter a New Name for the Scenario



- When a user modifies the inventory, all future results are affected as future analyses will use the updated inventory. If the inventory is modified, the analysis should be rerun. Users that plan on modifying the inventory should "duplicate" the Study Region to compare results, otherwise the results are overwritten. The results will be overwritten if and only if the user reruns the analysis on the same scenario.

Users that plan to modify the functions/parameters in the Damage and Loss Estimate analysis should use the **Save As** capability to compare results between scenarios, otherwise they are overwritten. The changes to damage functions are per Study Region, so the user is responsible for knowing which damage functions were used to create the results of which scenario. The user will not be able to display which damage functions were used for each scenario.

Users that plan to modify the hazard analysis do not need to use the **Save As** capability. However, a few cases must be taken into consideration:

Mix grid: Mix grids are created when Hazus does not know what return period to assign to the grid, such as the case of running a specific discharge analysis or assigning different return periods to different reaches in a single scenario. If a user is dealing with a mix grid case and reruns the hazard by changing some parameters (return period of one or more reaches, or the discharges), the changes to the depth grid and floodplain polygon due to this rerun will not be reflected in the loss analysis results until the loss analysis is rerun.

Edits to scenario: If a user reruns the hazard by adding or subtracting at least one reach from the scenario but uses the same return period, the user should rerun the loss analysis so that the results reflect the changes to the hazard.

FIT/User Depth Grids/.FLT Depth Grids: FIT results can only be modified in FIT. Inside the Flood Model, the only option available to the user in terms of modifying FIT/User Depth Grid/.FLT Depth Grid results is to choose which FIT Areas/User Depth Grid/.FLT Depth Grid

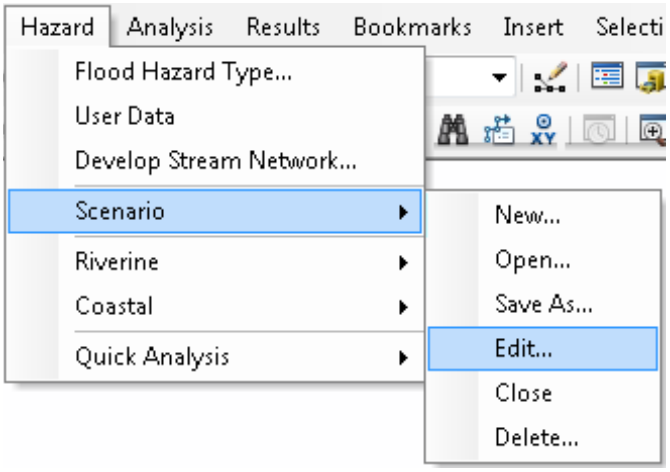
polygons to include in the scenario. If that kind of modification is made to the hazard, the user should rerun the flood delineation analysis so that the results reflect the changes to the hazard.

In all three cases, if the user reruns the analysis without using the **Save As** capability, the previous results will be lost.

6.4.4 Edit

The **Edit** option under the **Scenario** menu, shown in Figure 6-44, allows users to add/remove reaches to the scenario. If a user has not selected the correct reaches or shoreline, the **Edit** option allows the user to go in and re-select the correct reaches or shoreline.

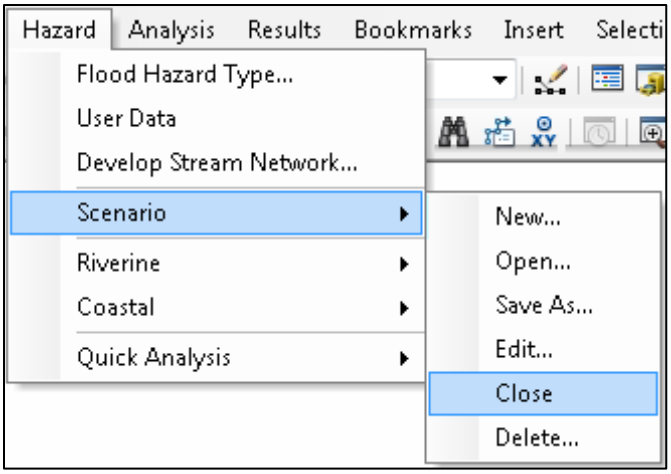
Figure 6-44: Select Edit



6.4.5 Close

The **Close** option under the **Scenario** menu, shown in Figure 6-45, closes the scenario in the mxd. The scenario is not deleted, but will not be the active scenario for any changes or updates.

Figure 6-45: Select Close



6.4.6 Delete

The **Delete** option under the **Scenario** menu, shown in Figure 6-46, allows users to delete scenarios that are no longer needed. The **Delete** option allows users to delete multiple scenarios all at once by clicking on the scenarios. To use the **Delete** capability, the scenario to be deleted must be closed. Select **Delete** from the **Scenario** menu. The **Delete Scenario** dialog will appear (Figure 6-47). Select the scenario(s) to be deleted and click **OK**.

Figure 6-46: Select Delete

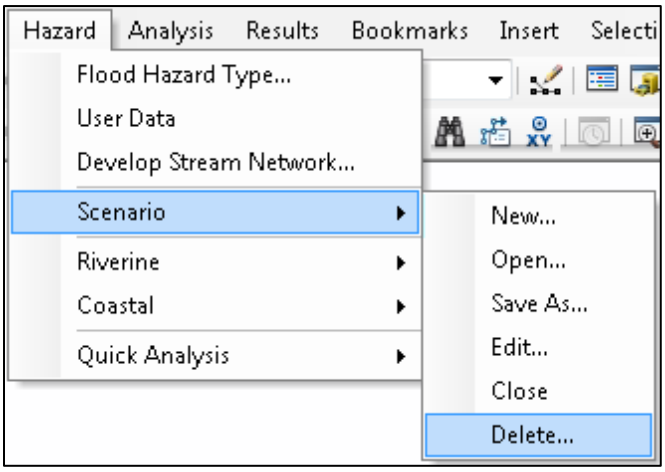
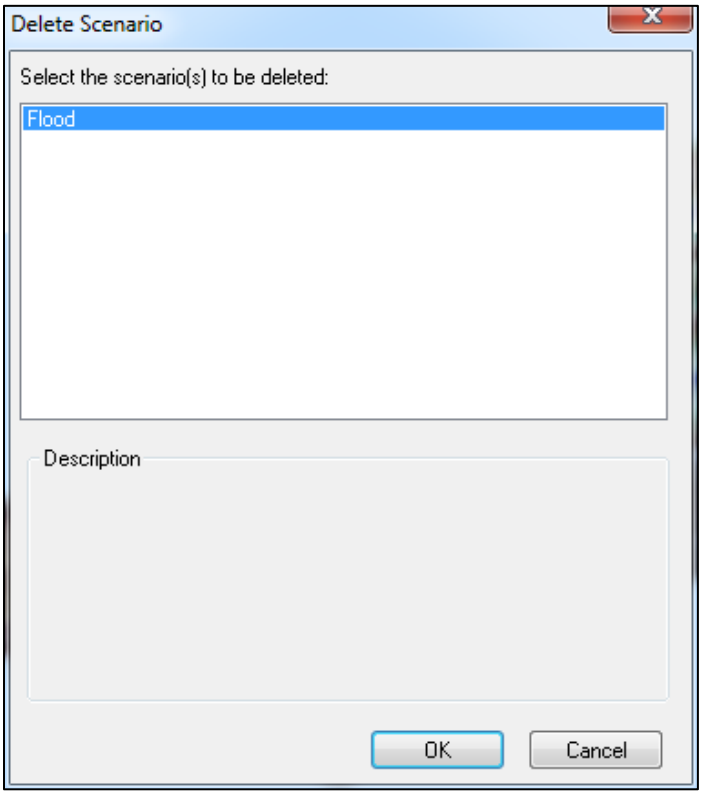


Figure 6-47: Delete Scenario Dialog

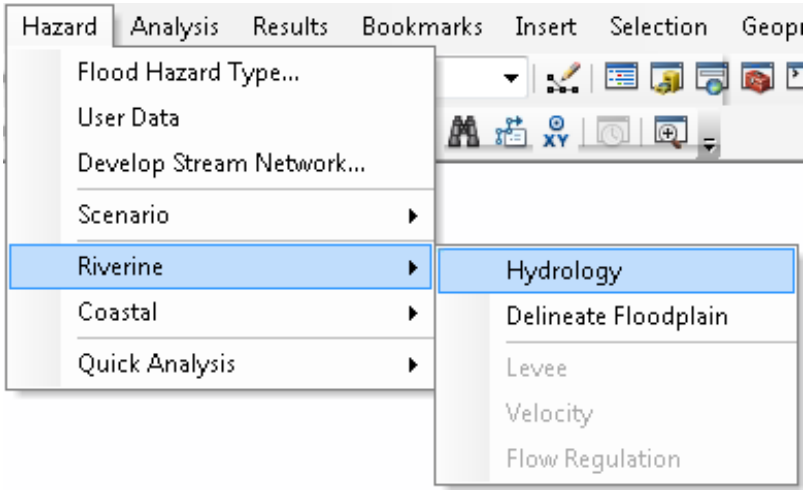


NOTE: To delete a scenario, manually close out of all references to the scenario itself or any of the scenario directory sub-tree files, such as log files, rasters, shapefiles, personal geodatabases, and file geodatabases in either texteditor, ArcCatalog, ArcMap, or Windows Explorer. Failure to do so will result in an incorrect sync between the scenario database-related data and their file system-related objects.

6.5 Riverine

The **Hazard / Riverine** menu provides the Flood Model riverine analyses for deriving peak flows (**Hydrology**) and associated flood depths and boundaries (**Delineation Floodplain**). The Flood Model also offers the ability to simulate levees (**Levee**), impacts of fast flowing flood (**Velocity**), and flood control measures that regulate flow (**Flow Regulation**). Like other Hazus analyses, this menu requires the analyses to be performed in sequential steps. For example, Figure 6-48 shows the **Hydrology** and **Delineation Floodplain** selections active, while the other three selections are inactive.

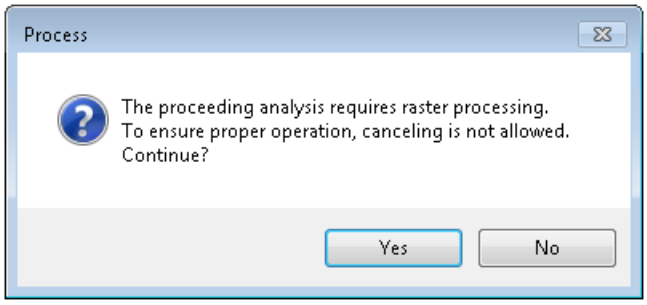
Figure 6-48: Select Hydrology



6.5.1 Hydrology

Once the user has defined the scenario, the **Hydrology** option, on the **Hazard / Riverine** menu, becomes enabled (Figure 6-48). To conduct the hydrologic analysis, select **Hydrology** and a notification window (Figure 6-49) will warn the user that raster processing cannot be canceled. Click **Yes**.

Figure 6-49: Select Yes to Start Hydrologic Analysis



A progress bar (Figure 6-50) will appear as Hazus performs the hydrologic analysis. This may take several minutes to several hours depending on the size of the Study Region and the number of selected streams. A notification (Figure 6-51) will appear once the hydrologic analysis has been completed. Click **OK**.

Figure 6-50: Hydrologic Analysis Progress

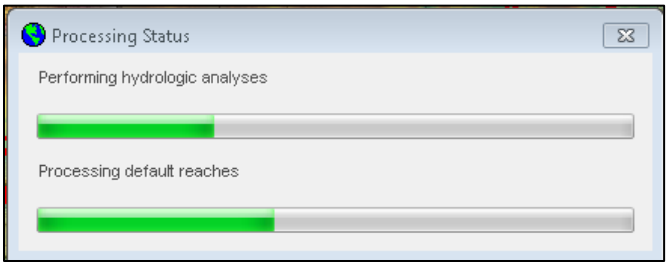
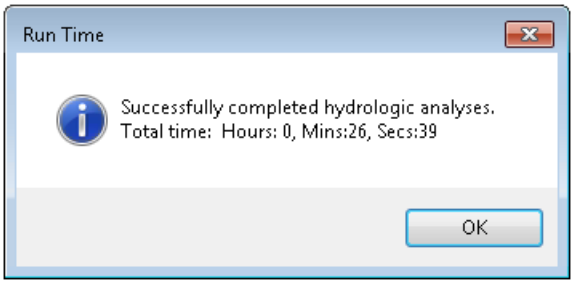


Figure 6-51: Hydrologic Analysis Completed



6.5.1.1 Best Practices and Troubleshooting

There is a tendency for ArcMap and Hazus to experience runtime issues that can lead to the Flood Model failing to complete the analysis. Because the hydrologic analysis is specific to the Study Region and is dependent only on the river network developed by the user, there are options to reduce the possibility of the code reaching a memory limit.

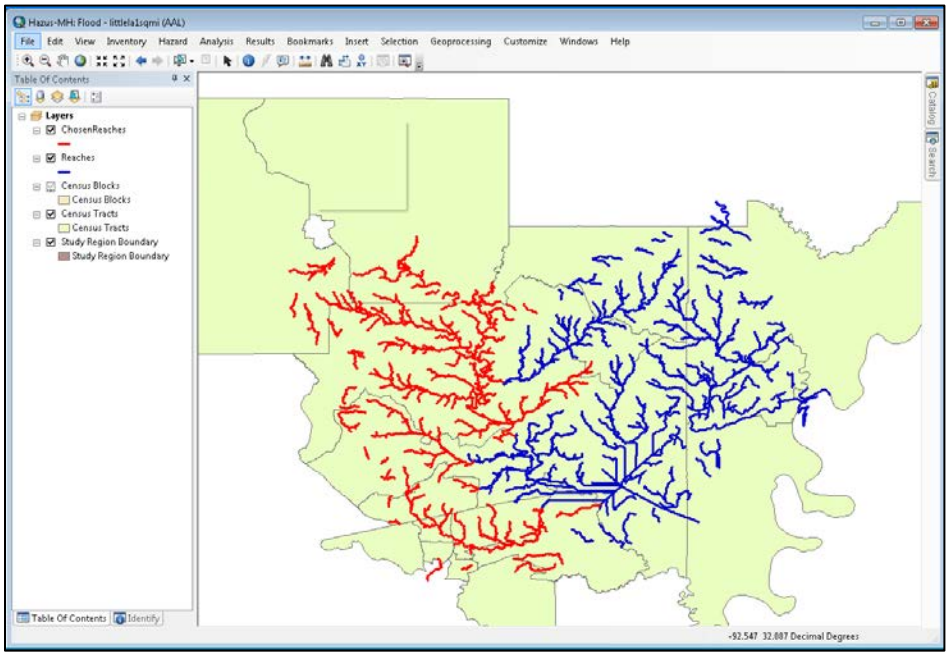
Performing the hydrologic analysis on a watershed-by-watershed basis is recommended, thereby limiting the processing within the model. Here are two recommended approaches:

1. Create a scenario for each watershed and then perform the hydrologic analysis on each scenario. The hydrologic results are stored in a single table independent of scenario.

2. Create a single scenario, start with one county or watershed and perform the hydrologic analysis. When completed, edit the scenario, add the next county or watershed and rerun the hydrologic analysis. The model will skip those reaches for which the hydrologic analysis has already been performed and will perform the analysis on the added reaches. Repeat as needed to complete all watersheds in the Study Region.

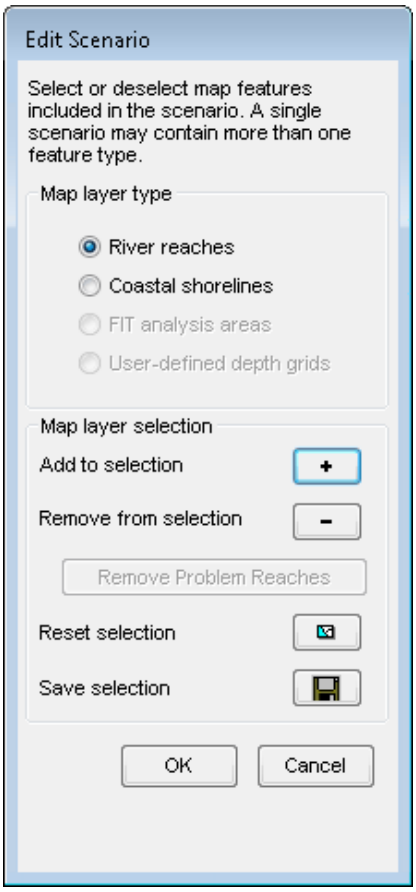
For scenarios with a large number of stream reaches, running the hydrologic analysis for large areas is recommended to improve processing time. Figure 6-52 provides an example showing reaches selected for analysis (shown in red).

Figure 6-52: Select Streams for Hydrology



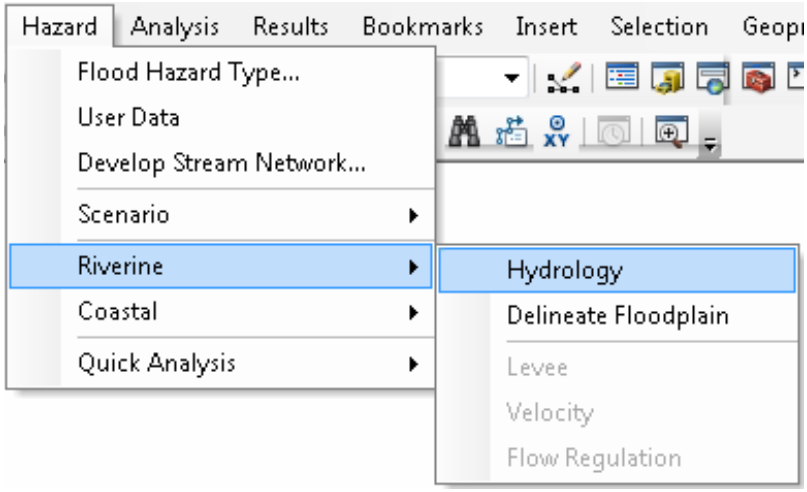
When running hydrologic analysis on large stream networks, continue to add streams by editing the scenario using the **Edit Scenario** dialog shown in Figure 6-53.

Figure 6-53: Edit Scenario Dialog to Add Streams



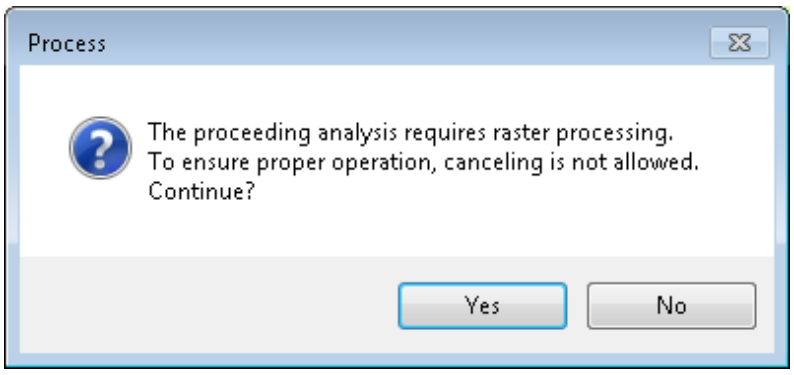
Once streams have been added into the scenario, select **Hydrology** from the Riverine menu as shown in Figure 6-54.

Figure 6-54: Select Hydrology



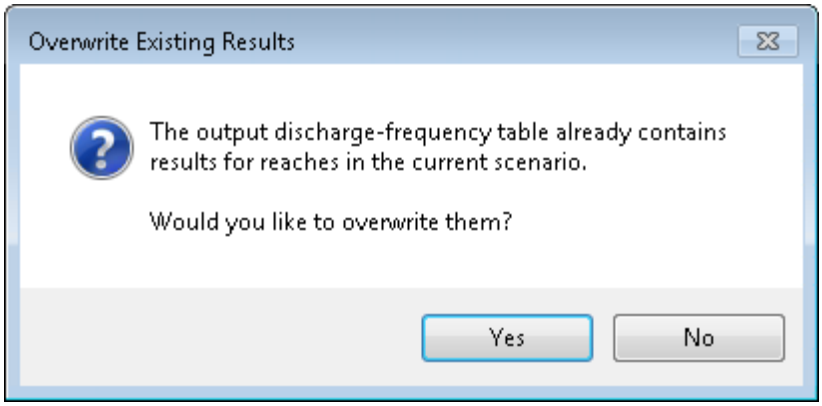
The **Process** dialog (Figure 6-55) will appear and ask if the user wants to continue with the processing. Click **Yes** to continue. Once the hydrologic analysis has started, the process cannot be canceled.

Figure 6-55: Hydrology Processing Dialog



Once the user has edited the scenario and added more streams for hydrologic analysis, the **Overwrite Existing Results** dialog will appear (Figure 6-56). If the user selects **Yes** to overwrite, Hazus will overwrite previous hydrology values, which requires more processing time. If the user selects **No**, the new results will be appended to the previous results and stored.

Figure 6-56: Overwrite Hydrology Dialog



Hydrologic analysis is only important for performing frequency-related flood analyses (i.e., 100-year return period, annualized loss, etc.). If the user wishes to apply a specific discharge to the reach(es), they should proceed directly to the **Delineate Floodplain** option on the **Riverine** menu and select **Single Discharge** (see Section 6.5.2).

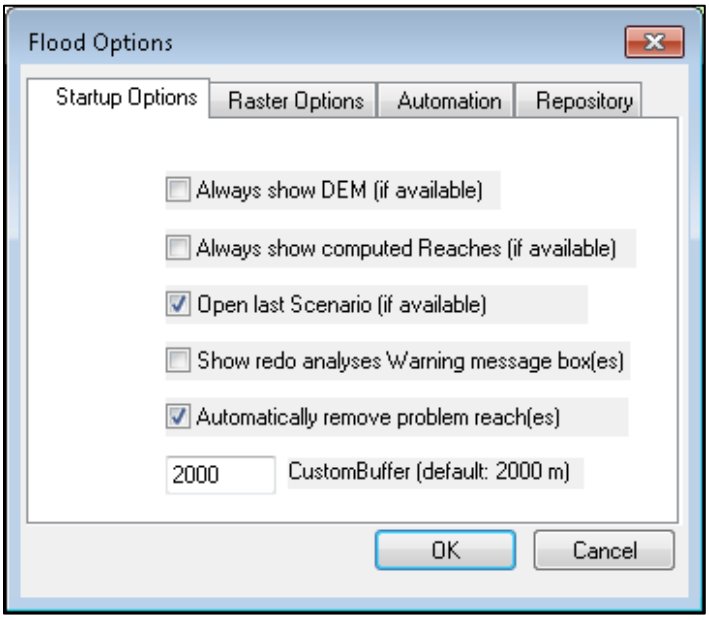
When running hydrologic analysis, the Hazus screen might go blank or the Task Manager **Applications** tab will indicate that Hazus is not responding. This is a common occurrence for any process-heavy software. To see whether Hazus is still running, check the Task Manager **Processes** tab and sort the **CPU** column in descending order. The “ArcMap.exe” process should be on top. If the “System Idle Process” is constantly on top at 99–100%, Hazus is not responding. Also, check the **Performances** tab and make sure the CPU Usage is not 0 over a period of time. Another option is to open the Study Region folder (in “Details” view within Windows Explorer) and make sure the FlHydrologyLog.txt file is updating by looking at the “Date modified.”

6.5.1.2 Excluding Problem Reaches from Scenario

Problem reaches are reaches for which regression equations and/or data are not available. When computing the flood hazard, analysis results for a specific return period or suite of return periods will not be available for reaches designated as Problem Reaches. Input of discharges will be required to develop the flood hazard grids for Problem Reaches.

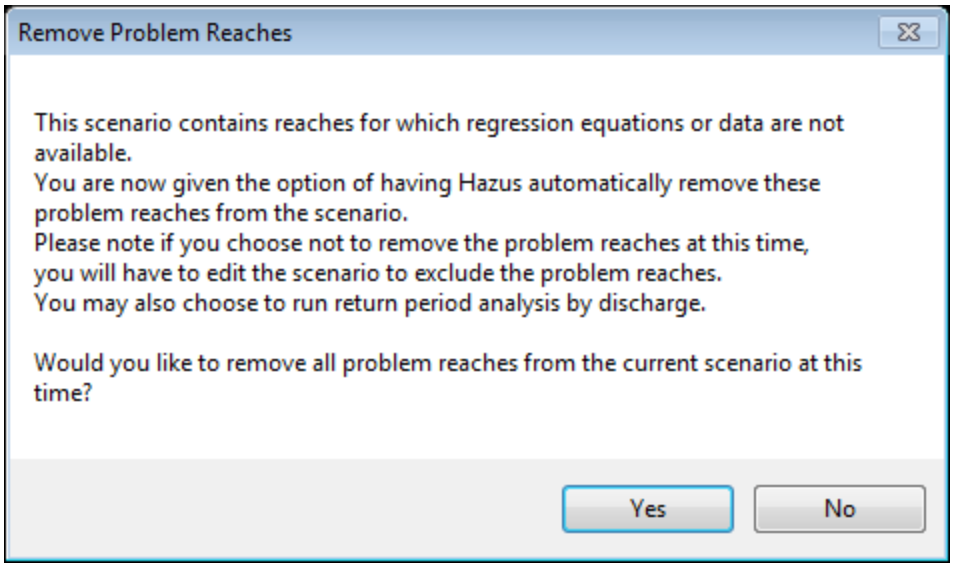
Users have the option to set Hazus to automatically remove problem reaches (if they exist) from the scenario after the hydrologic process by selecting the **Automatically remove problem reach(es)** checkbox under **Customize** > **Flood Options** on the main Hazus menu bar, as shown in Figure 6-57.

Figure 6-57: Flood Options, Check Automatically Remove Problem Reach(es)



If the **Automatically remove problem reach(es)** checkbox is not selected, at the end of the hydrologic process, a **Remove Problem Reaches** message will appear, as shown in Figure 6-58, to notify the user that problem reaches exist in the scenario and to give the user the option to remove the problem reaches from the scenario (with one click of **Yes** button).

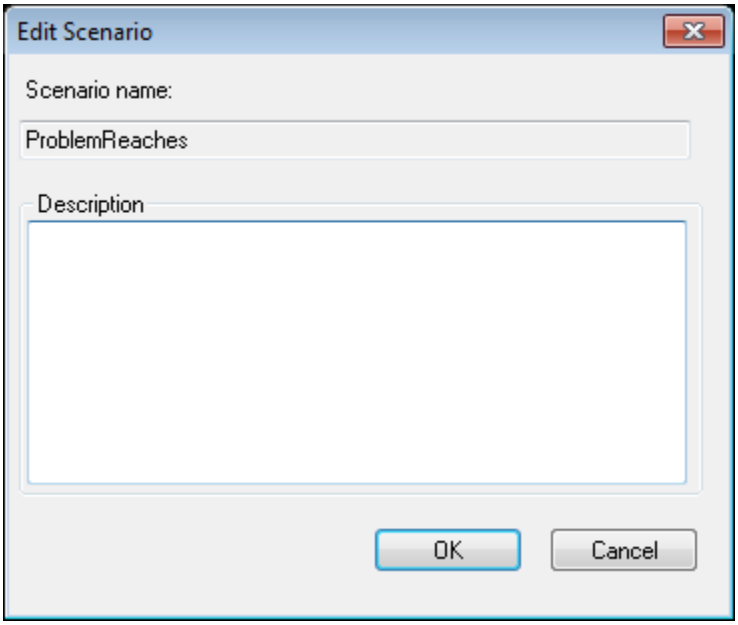
Figure 6-58: Notification and Option to Remove Problem Reaches



If the user selects **No** in the **Remove Problem Reaches** notification, but later wishes to remove problem reaches, they can manually edit the scenario to exclude the problem reaches. This only applies to cases where the problem reaches exist in the scenario.

To manually remove problem reaches, click on the **Hazard** menu, select **Scenario**, and then click **Edit**. The **Edit Scenario** dialog will open, as shown in Figure 6-59. Click **OK**.

Figure 6-59: Edit Scenario Window



Once the user clicks **OK,** all of the reaches in the scenario will be highlighted in light blue. Click the **Remove Problem Reaches** button (as shown in Figure 6-60), to remove all of the problem reaches, and then click the **Save selection** button. After the user clicks **OK**, the new scenario will be mapped, shown in Figure 6-61.

Figure 6-60: Edit Scenario Dialog to Remove Problem Reaches

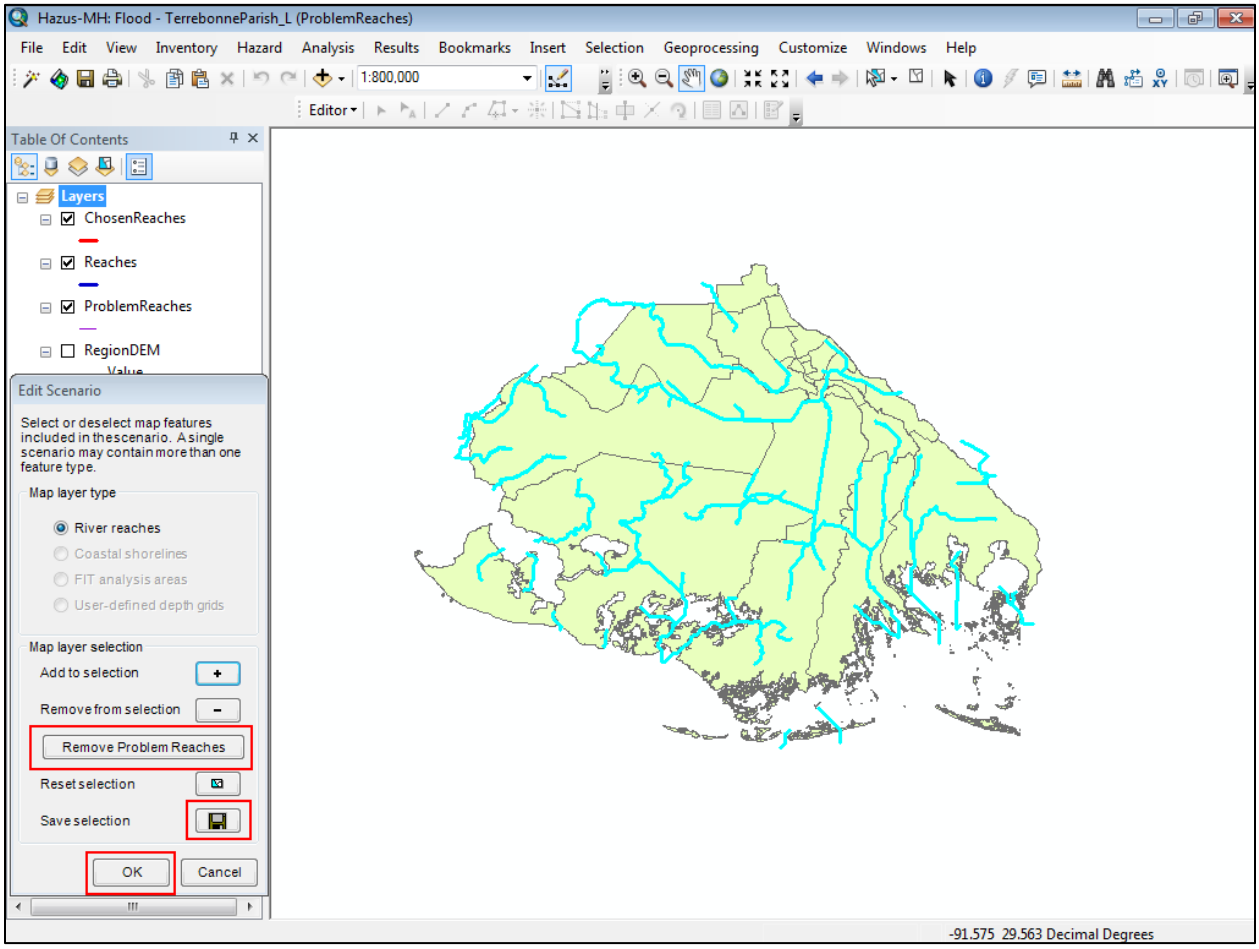
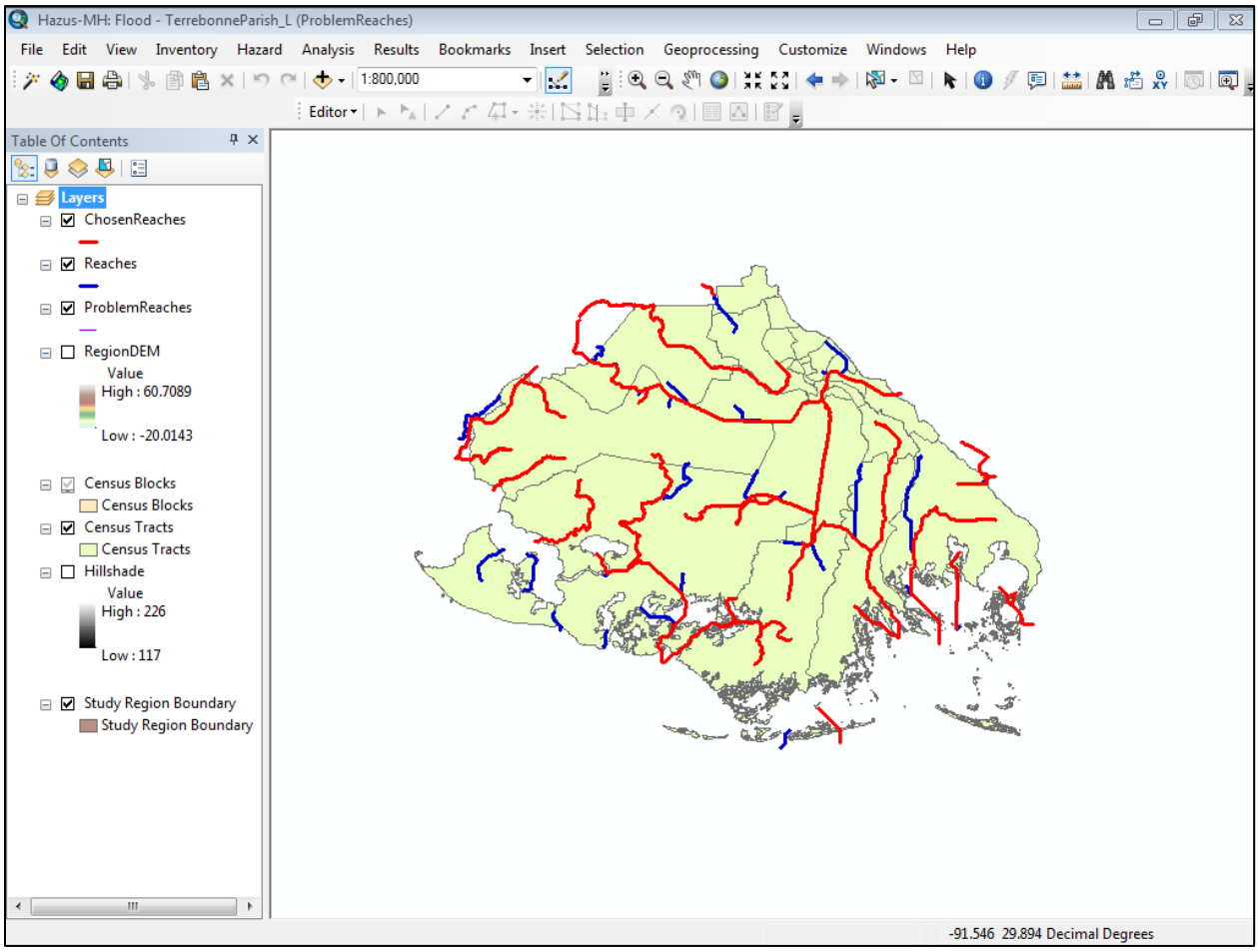


Figure 6-61: Example Edited Scenario with Problem Reaches Removed



The scenario is now ready to start hydraulics (**Riverine** > **Delineate Floodplain**) for the Chosen Reaches. The hydrologic analysis does not need to be rerun because Hazus has already computed discharges for non-Problem Reaches. If the hydrologic analysis is rerun, the results will remain the same because the Problem Reaches have been removed from the scenario.

6.5.2 Delineate Floodplain

Once the hydrologic calculations are complete, the **Delineate Floodplain** option on the **Hazard / Riverine** menu is enabled (Figure 6-62). Select **Delineate Floodplain** to initiate the hydraulic analysis. The **Riverine Hydraulic Analysis** dialog in Figure 6-63 will appear. Use the **Analysis Type** pull-down menu to select the type of hazard analysis to run.

Figure 6-62: Select Delineate Floodplain

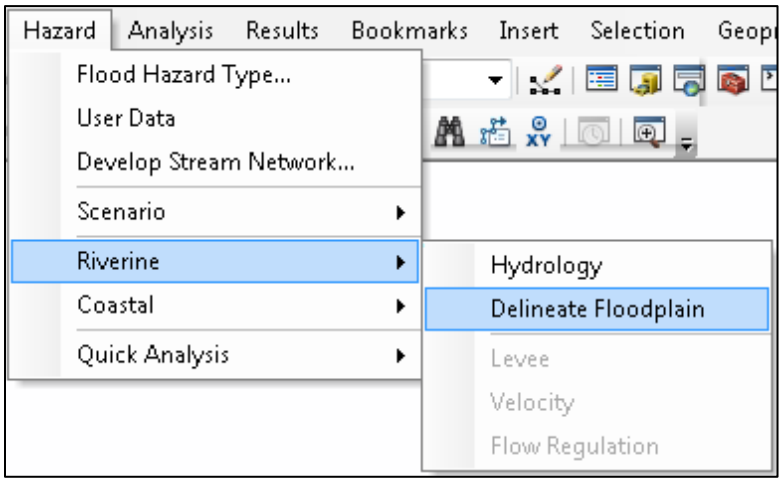
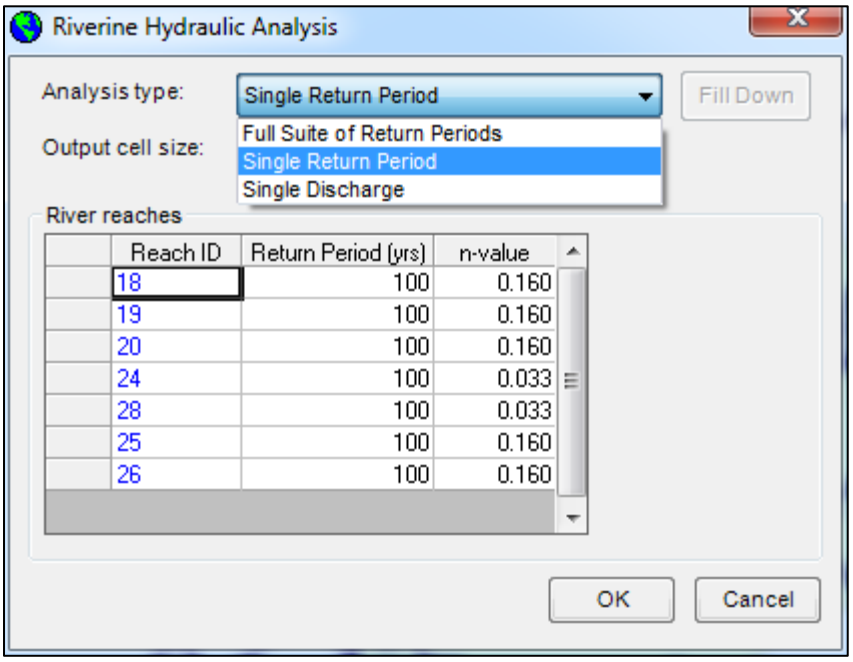


Figure 6-63: Riverine Hydraulic Analysis Dialog



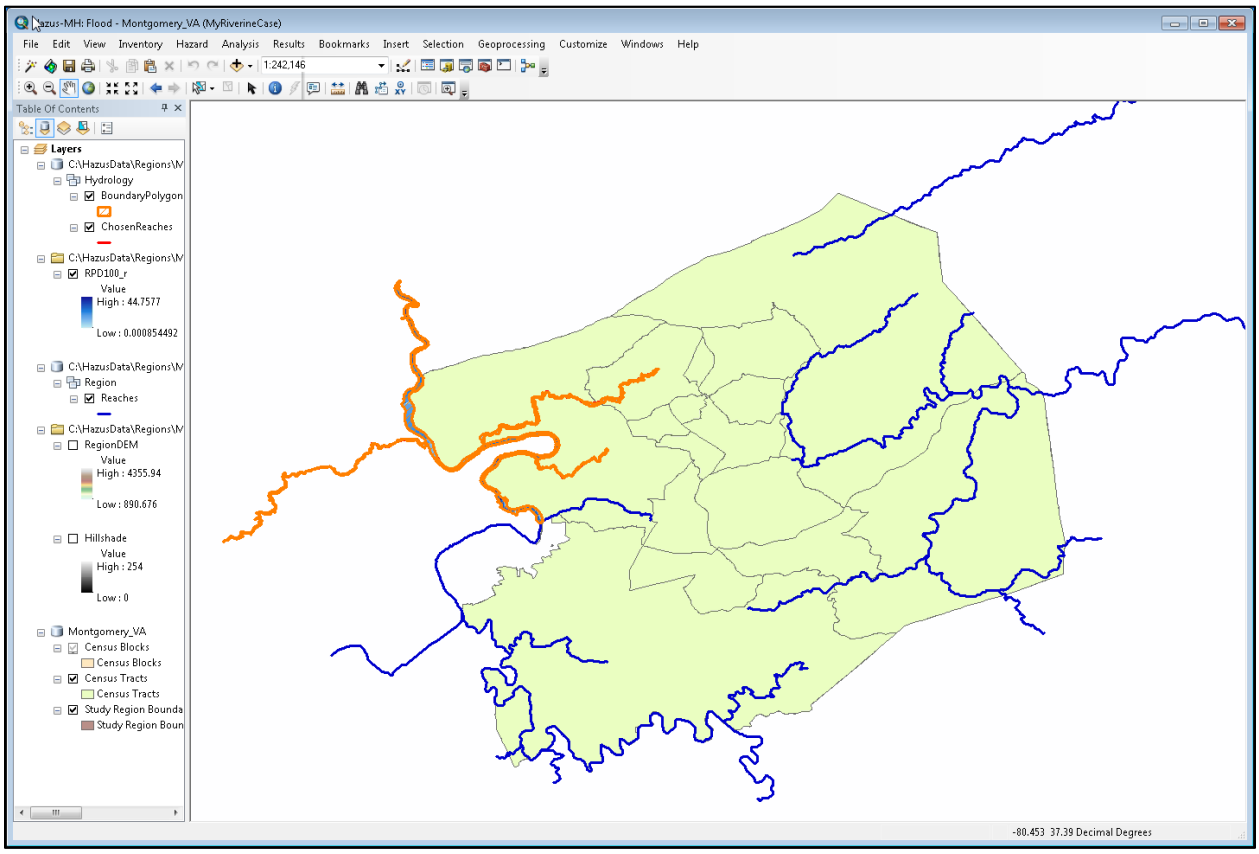
1. Select **Full Suite of Return Periods** to calculate flood depths and floodplains for the 10-year, 25-year, 50-year, 100-year, and 500-year return period floods on each of the stream reaches in the scenario. Starting with the 500-year return period, the Flood Model will go through each selected reach and develop a single 500-year flood depth grid. This process is duplicated for the other four return intervals. This option is required for average annualized loss.
2. Select **Single Return Period** to specify a return period between 2 years and 1,000 years for which the flood characteristics will be calculated. Choose different return periods for different stream reaches, if desired. Depending on the user selection, the

resultant grid will be a single return interval for all reaches selected by the user, similar to option 1 above, or a single grid of mixed return intervals for the selected reaches.

3. Select **Single Discharge** to input anticipated stream discharge levels for each stream reach. Similar to option 2 above, the user can enter different discharges for each reach.
    - If the user opts to run different return intervals or specific discharges for each reach in their scenario, the Transportation Bridge analysis cannot be run because the return interval for the reaches in question needs to be specified and has not been defined for a single discharge analysis.
    - The **Single Discharge** option can decrease the runtime significantly if data are available.

The final delineated floodplain should look like Figure 6-64, where only the selected reaches for the scenario have flood depth grids and boundaries delineated.

Figure 6-64: Example Riverine Hydraulic Analysis Results



6.5.2.1 Best Practices and Troubleshooting

The **Delineate Floodplain** analysis can take large amounts of time, especially when generating a flood depth grid in Hazus rather than importing a grid. Several days of processing time are possible with the **Full Suite of Return Periods** Analysis Type for an individual county. Some general guidance is listed below for the **Delineate Floodplain** analysis; however, this is not an exclusive list of best practices and troubleshooting for issues experienced during the **Delineate Floodplain** analysis. Please contact the Hazus Helpdesk (contact info in Chapter 1) for support regarding specific issues.

Blank Screen:

When running the hydraulic analysis, the Hazus screen might go blank or the Task Manager **Applications** tab will indicate that Hazus is not responding. This is a common occurrence for any process-heavy software. To see whether Hazus is still running, check the Task Manager **Processes** tab and sort the **CPU** column in descending order. The "CoreOfHydraulics.exe" process should be on top. If the "System Idle Process" is constantly on top at 99–100%, Hazus is not responding. Also, check the **Performances** tab and make sure the CPU Usage is not 0 over a period of time. Another option is to open the scenario folder (in "Details" view within Windows Explorer) and make sure the FlHydraulicsLog.txt file is updating by looking at the "Date modified."

Grid Cell Sizes:

Using a smaller cell size could dramatically increase the processing time and the size of the output raster. Resampling larger cells into smaller cells to allow a merged grid for study regions with different topographic source data may lead to issues in Hazus. The recommended approach would be to run the multiple source depth grids separately in Hazus and then combine flood loss results after all Hazus loss runs.

Reaches with Hydraulic Problems:

If running the hydraulics (i.e., **Delineate Floodplain**) is taking a long time, the hydraulic process may be hanging (i.e., getting stuck on a couple of reaches so that it cannot finish the hydraulics). The following instructions will help bypass the problem.

1. Look in the log (flHydraulicsLog.txt located in Scenario folder) and note any reaches (ReachID) that have many errors and did not successfully complete processing. Example below:

```
: ----------------------------------------------------------------------
 : ReachID: 202  Core of Hydraulics
: ----------------------------------------------------------------------
modLevelOne - CoreOfHydraulics: Reach 100 of 267
modLevelOne - CoreOfHydraulics: Return period: 100
modLevelOne - CoreOfHydraulics: What-if:
modLevelOne - CoreOfHydraulics: Available memory: 1631.05 mb
modInitialBuffer - InitBuffer: Reach length = 0.2 km
modInitialBuffer - InitBuffer: Reference (downstream node) discharge: 3,981 cfs
modXSections - PlaceInitXsects: Short centerline length: 964.462826043346 feet
```

modXSections - PlaceInitXsects: Buffer 3 of 9

modXSections - PlaceInitXsects: Buffer 4 of 9

modXSections - PlaceInitXsects: Buffer 5 of 9

modXSections - PlaceInitXsects: Buffer 6 of 9

modXSections - PlaceInitXsects: Buffer 7 of 9

modXSections - PlaceInitXsects: Buffer 8 of 9

modXSections - PlaceInitXsects: Buffer 9 of 9

modXSections - PlaceInitXsects: Cross section count: 3

modXSections - InitialXSectElevs: Drainage area reset from 219.9631 to 140.0594

modXSections - InitialXSectElevs: Drainage area reset from 220.2029 to 140.0594

GeometryToFeatureClass: Feature class: LeftBuffer

GeometryToFeatureClass: Feature class: RightBuffer

modGeometry - CleanPolygonIslands: Input geometry is nothing, leaving early.

ModBoundsandEnds - ValidateFloodPolygon: Error Number: 91

ModBoundsandEnds - ValidateFloodPolygon: Error: Object variable or With block variable not set

modGeometry - CleanPolygonIslands: Input geometry is nothing, leaving early.

modGeometry - IntersectABS: Input geometry #1 is invalid. No intersection.

modLimits - NewLimitsandCenterlines: Error Number: 91

modLimits - NewLimitsandCenterlines: ERROR: Object variable or With block variable not set at 8

modLevelOne - CoreOfHydraulics: Error Number: 91

modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 20

modLevelOne - CoreOfHydraulics: Error Number: 91

modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 20

modLevelOne - CoreOfHydraulics: Error Number: 91

modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 20

modLevelOne - CoreOfHydraulics: Error Number: 91

modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 20

modWsePts - FinalWsePts: Error Number: 5

modWsePts - FinalWsePts: ERROR: Invalid procedure call or argument at 2

modLevelOne - CoreOfHydraulics: WARNING: FinalWsePts failed, continuing process using points from InitialWsePts and/or IncreaseWsePts

modLevelOne - CoreOfHydraulics: Error Number: 91

modLevelOne - CoreOfHydraulics: ERROR: Object variable or With block variable not set at 45

modAddBack - AddBack: Entering

modAddBack - FillDEMMask: Error Number: 91

modAddBack - FillDEMMask: ERROR: Object variable or With block variable not set at 4

modAddBack - AddBack: Error Number: 91

modAddBack - AddBack: ERROR: Object variable or With block variable not set at 5

MakePermanent: Entering for grid: 202

MakePermanent: Path: C:\Program Files\HAZUS-MH\StudyRegion\PSchneider_NV5County\Hydraulics\Reaches\100

MakePermanent: Leaving

modAddBack - AddBack: Leaving

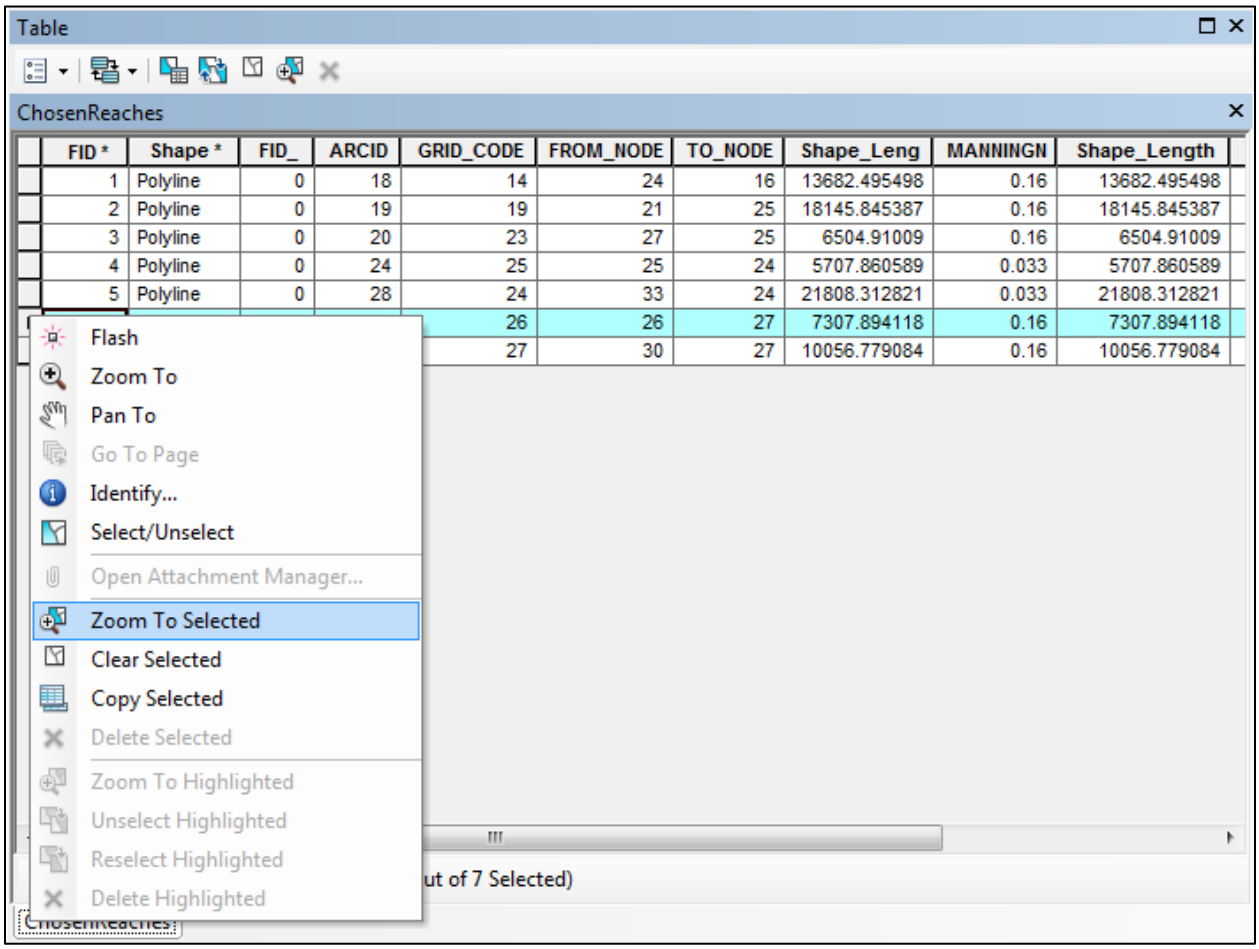
GeometryToFeatureClass: Feature class: 202_cl

ExportGDBFClass: Error: Featureclass Reach202ConvPGRP100 not found.

modLevelOne - CoreOfHydraulics: Leaving

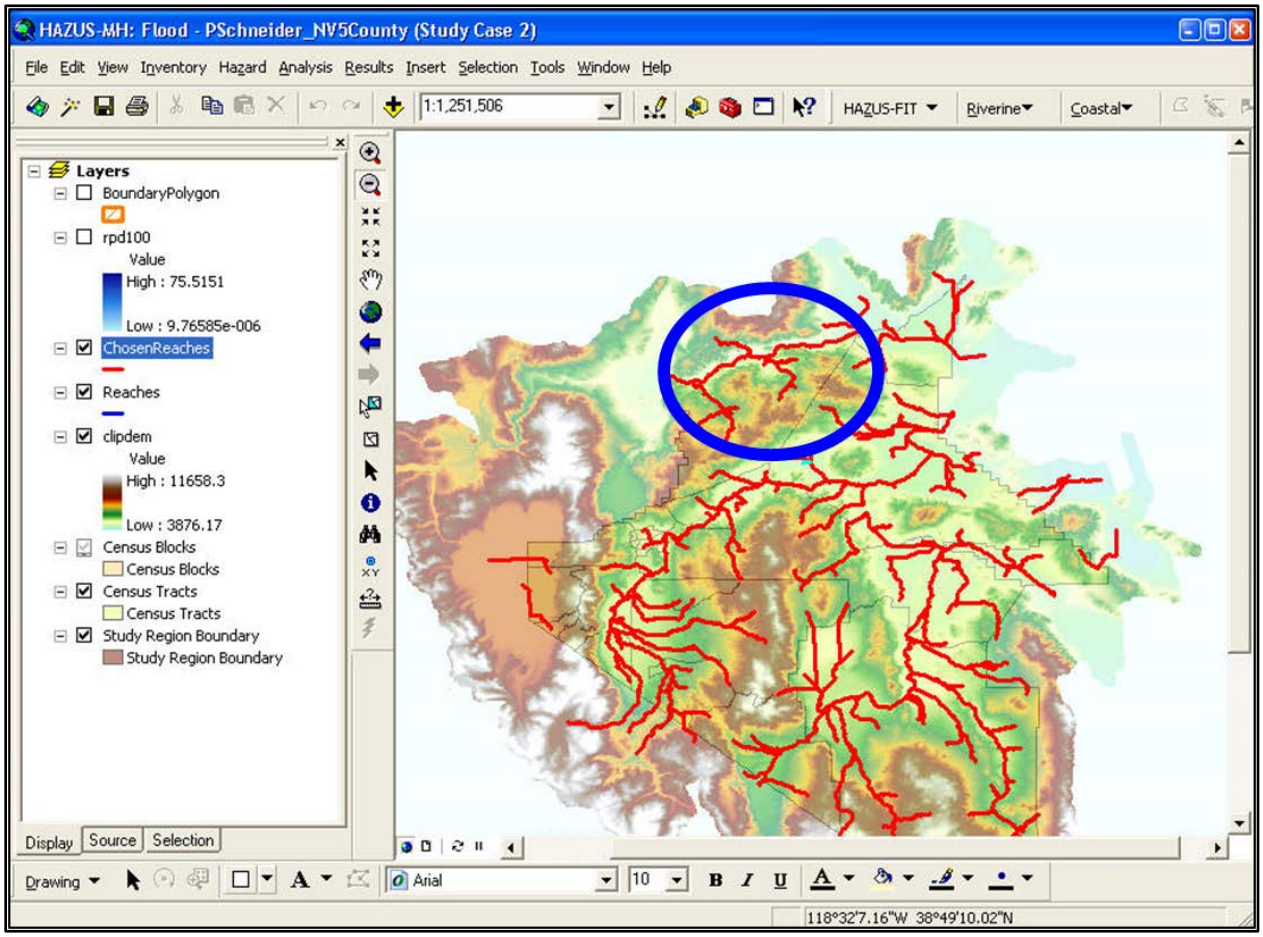
2. Open the Attribute Table for the Chosen Reaches layer.
3. Search for the reach using the ArcID and highlight/select the problem reach.
4. Right click on the line of the selected reach and select **Zoom to Selected** as shown in Figure 6-65 below.

Figure 6-65: Chosen Reaches Attribute Table, Zoom to Selected Reach



5. The map will now zoom into the reach selected. Zoom out of the map to locate where the selected reach is on the map (Figure 6-66). Keep in mind what the reach looks like.

Figure 6-66: Example Selected Chosen Reach (highlighted), Zoomed Out



6. Click on the **Hazard** menu, select **Scenario**, then click **Edit**.
7. Once the **Edit Scenario** tool is available, zoom in to the area where the problem reach is located.
8. Click **Remove from selection** and select the problem reach. The reach selected will be highlighted in red.
9. Click **Save selection**.
10. After the selection has been saved, the problem reach will be dark blue and will be excluded from the scenario.
11. Click **OK**.
12. If the scenario is a riverine/coastal scenario, the **Shoreline Characterization** dialog will appear after edits are made to the scenario. The original parameters that were set for the shoreline(s) are saved if the shoreline(s) wasn't added/removed from the scenario. Select the **Nex**t and **Finish** buttons if the existing parameters are desired.
13. The scenario is now ready to re-start hydraulics (Riverine\Delineate Floodplain) for the ChosenReaches. The hydraulics process will automatically rerun any reaches that did not successfully process in the previous run, skip any reaches that have been

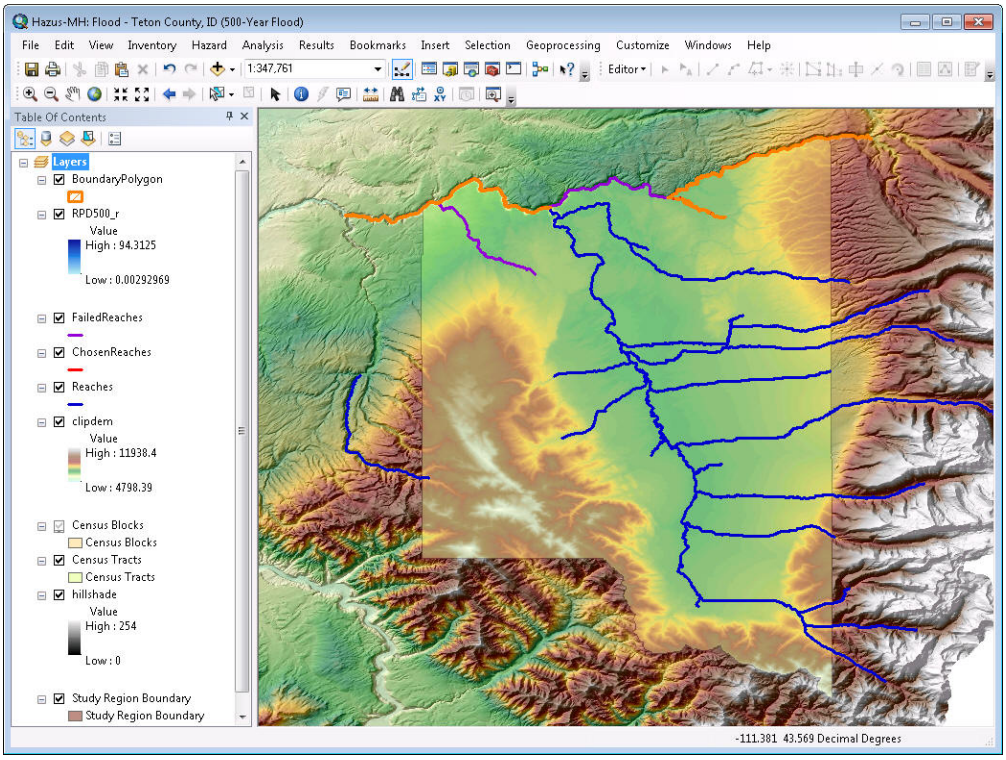
successfully processed, and then will continue on the last reach processed. If there were any reaches where the Task Manager was used to stop Core of Hydraulics, repeat the steps to get past those reaches.

6.5.2.2 Failed Reaches

Failed reaches are reaches that have been processed in the hydraulics process, but do not produce a flood depth grid. An error message will appear to notify the user when a reach fails during the hydraulics process, as shown in Figure 6-67. Click the **Close** button and the hydraulics process will continue processing the next reach in the queue. The **FailedReaches** layer will appear on the map after the hydraulics process completes, as shown below in Figure 6-68.

Figure 6-67: CoreOfHydraulics Error Message

Figure 6-68: Example FailedReaches (purple) on Map after Hydraulics Completed



The hydraulics process should complete even if there are failed reaches. The only reason the hydraulics process will not complete is if a failed reach causes the hydraulics process to hang.

When running the analysis on a scenario with failed reaches, the analysis will only process in areas where the depth grid exists.

The Flood Model Oversight Committee identified specific items that they believed would enhance the user community acceptance of the Flood Model. These capabilities provided a level of What-if functionality to the user, allowing them to utilize the Flood Model as a planning tool. The Flood Model What-if scenarios include riverine levee, riverine flow regulation, riverine velocity, coastal long-term erosion, and coastal shore protection. The following sections provide a description of the process to generate the hazard (depth grid) for the What-if analysis.

Use of What-if scenario functionality requires that the flood hazard is already computed. Levee, flow regulation, and velocity analyses require the riverine hazard to be completed. Long-term erosion and shore protection routines require the coastal hazard to have been completed.

6.5.3 Levee

In general, DEMs are not reliable for identifying a continuous embankment with relatively small width. Grid cells are connected at the corners and the sides. As such, an embankment that is not a straight line must be at least two cells wide to be considered a barrier to flow. The Hazus levee tool allows users to:

1. Add a levee alignment
2. Attribute the levee with a level of protection
3. Determine the effects of a levee on flood depths within the unprotected portion of the floodplain (Level 1 analyses)

Once the **Hydrology** and **Delineate Floodplain** analyses are complete, the options for **Levee**, **Velocity**, and **Flow Regulation** on the **Hazard / Riverine** menu are enabled. The Levee tool is available to add a levee alignment, attribute the levee with a level of protection, and determine the effects of a levee on flood depths within the unprotected portion of the floodplain

To conduct a Levee analysis, select **Levee** from the **Hazard / Riverine** menu (Figure 6-69). The **Levee What-If Scenario** dialog will appear (Figure 6-70). Draw the levee by clicking the **Draw** button. Flood depth grids are already created for the reach and the user must select a grid to draw the levee alignment. The alignment should cross the floodplain twice and must not cross the stream centerline. See example in Figure 6-71. Next, enter the recurrence interval (in years between 5 and 500) that corresponds to the level of protection provided by the levee in the **Levee What-If Scenario** dialog. Click **Save**, and then **OK**.

- Hazus allows users to zoom in or out of the map ***before*** clicking on the **Draw** button. After clicking on the **Draw** button, the tool is set to the Line tool, and the customization is locked; therefore, users will not be able to select any other tool until the levee is drawn.

Figure 6-69: Select Levee

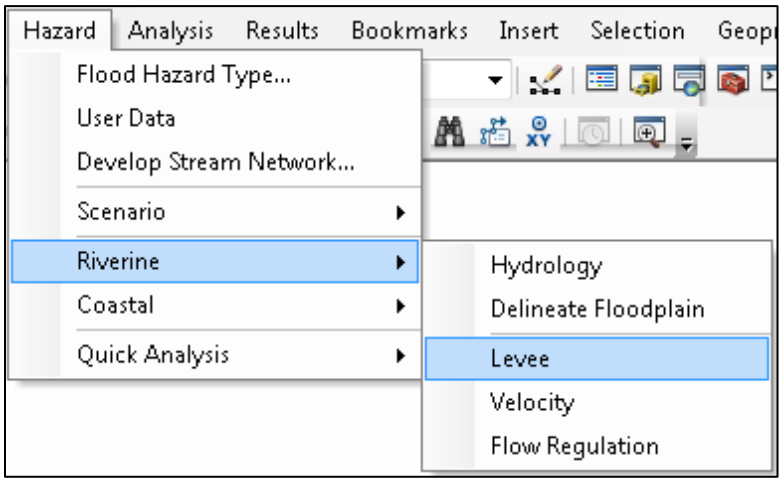


Figure 6-70: Levee Dialog

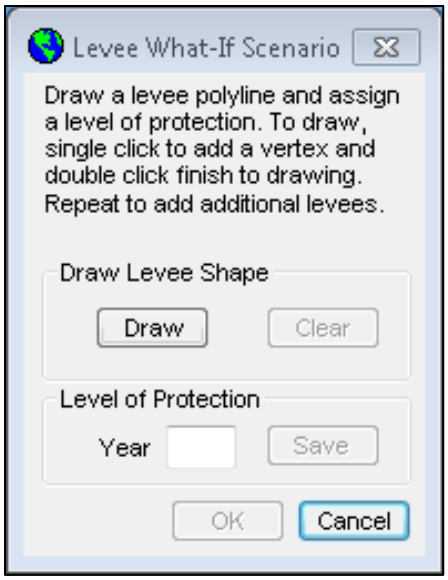
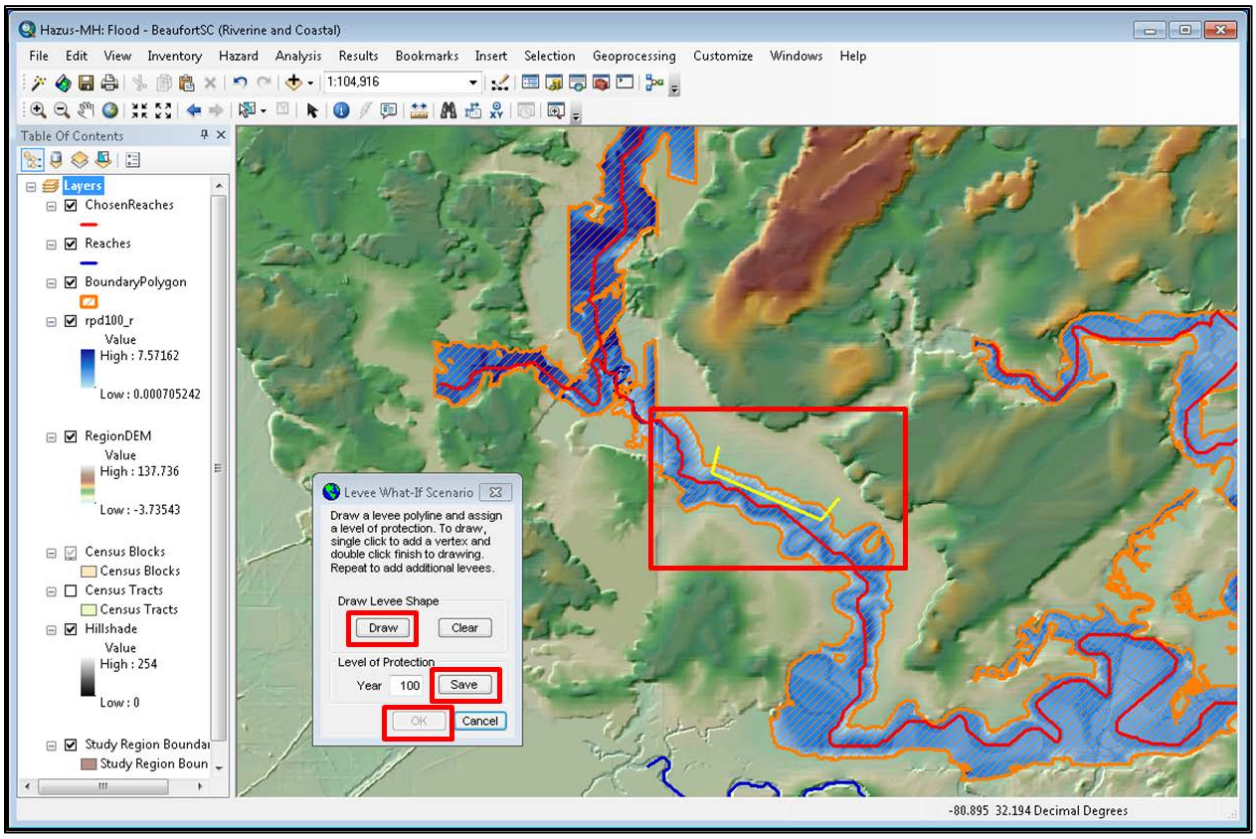


Figure 6-71: Example Riverine Levee



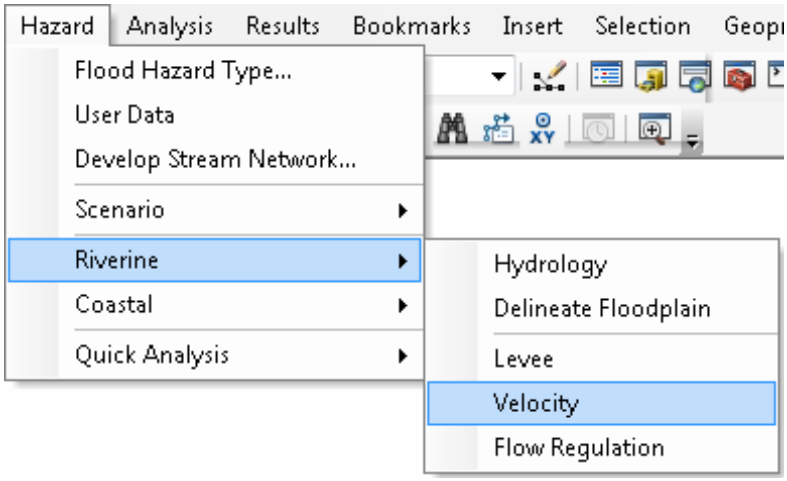
The model then inserts the levee into the DEM and the flood hazard for the scenario is recomputed.

6.5.4 Velocity

The velocity of floodwater contributes to the flood hazard by carrying large amounts of sediment and debris. This acts to impact structures and erode soil from stream banks and foundations. The velocity analysis estimates the spatial distribution of the floodwater velocities into general categories of low, medium, and high, but does not estimate an actual velocity value.

To conduct a riverine flow velocity analysis, select **Velocity** from the **Hazard / Riverine** menu (Figure 6-72).

Figure 6-72: Select Velocity



The **Process** dialog (not shown) will appear and ask if the user wants to continue with the processing. Click **Yes** to continue. Once the velocity analysis has started, the process cannot be canceled.

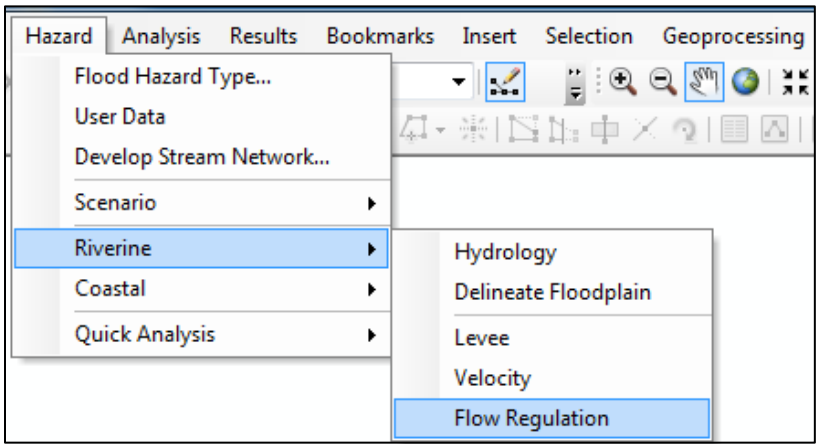
6.5.5 Flow Regulation

The default hydrologic analyses apply to unregulated drainage areas. Regulation, through diversions and/or storage, changes the flood frequency curves downstream. Hazus provides a tool for incorporating the downstream effects of flow regulation. The tool allows users to modify the unregulated flood frequency curve at a specific location by entering one or more pairs of recurrence intervals and discharge values. Hazus identifies downstream reaches affected and modifies the corresponding flood frequency curves as appropriate, prior to re-computing the flood hazard.

Select **Flow Regulation** from the **Hazard / Riverine** menu (Figure 6-73). The **Flow Regulation** dialog will appear as shown in Figure 6-74. Click the **Draw** button to identify the location of a regulating structure, such as a flood control reservoir. Click a spot on the map to designate the location of this structure. Next, click **Apply**. Once the **Apply** button is clicked, the algorithm finds the drainage area upstream of that location and defines the unregulated flood frequency curve. The curve is plotted and a table of recurrence intervals and associated discharge values is presented for the user. Enter the **Return Period** and **Discharge** of the regulating structure in the **Flow Regulation** dialog and click **OK**.

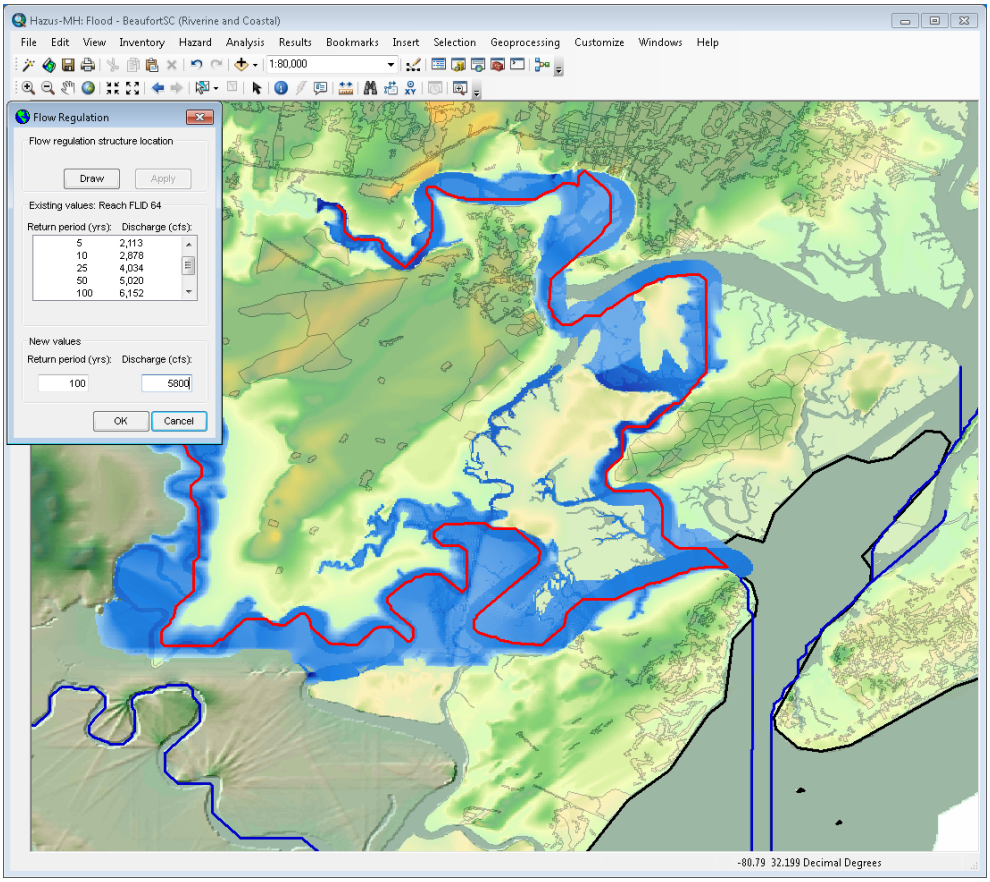
- Hazus allows users to zoom in and out of the map before clicking on the **Draw** button. After clicking on the **Draw** button, users will not be able to select any other tool until the regulation structure is drawn.

Figure 6-73: Select Flow Regulation



The **Process** dialog (not shown) will appear and ask if the user wants to continue with the processing. Click **Yes** to continue. Once the velocity analysis has started, the process cannot be canceled.

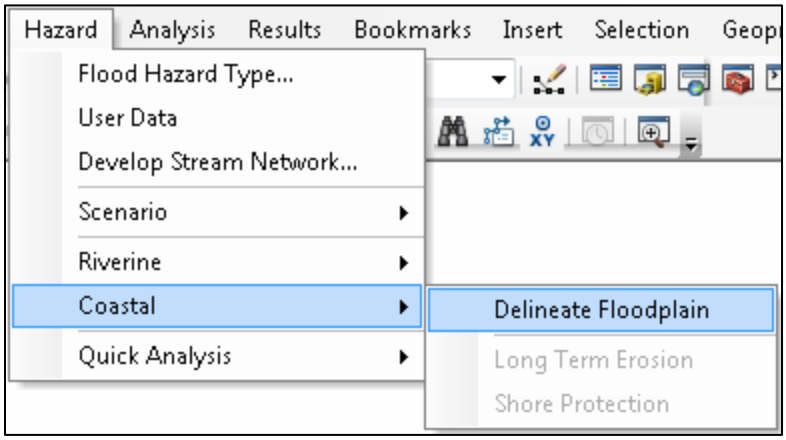
Figure 6-74: Riverine Flow Regulation Dialog



6.6 Coastal

The **Hazard / Coastal** menu (Figure 6-75) provides the Flood Model coastal analyses for deriving flood depths and boundaries (**Delineation Floodplain**) associated with the coastal flood elevations and shoreline segments entered when defining the scenario. The selections for **Long Term Erosion** and **Shore Protection** are unavailable in the current version of Hazus. Therefore, the selections are disabled by design and will not be covered in this User Manual.

Figure 6-75: Select Delineate Floodplain

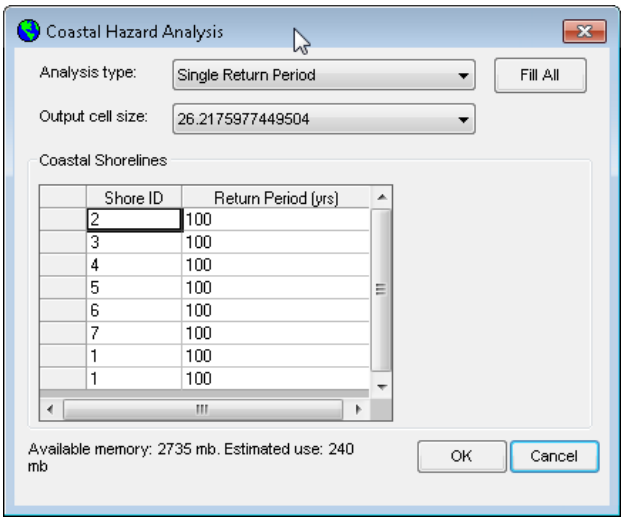


6.6.1 Delineate Floodplain

To delineate the floodplain, select **Delineate Floodplain** from the **Hazard / Coastal** menu (Figure 6-75). The **Coastal Hazard Analysis** dialog will open (Figure 6-76). This dialog allows the user to select from two coastal analysis options:

1. If the user selects **Full Suite of Return Periods** from the **Analysis Type** drop-down menu, Hazus will calculate flood depths and floodplains for the 10-year, 25-year, 50-year, 100-year, and 500-year return period floods for the entire shoreline in the scenario. The Flood Model will produce a single flood depth grid for the shoreline for each of the five return intervals.
2. If the user selects **Single Return Period** from the **Analysis Type** drop-down menu, the user can specify any flood return period between 10 and 500 years for which the flood characteristics will be calculated. Unlike the riverine hazard, the user cannot choose different return periods for different shoreline segments. The Flood Model will produce a single flood depth grid for the shoreline for the selected return period.

Figure 6-76: Coastal Hazard Analysis Dialog



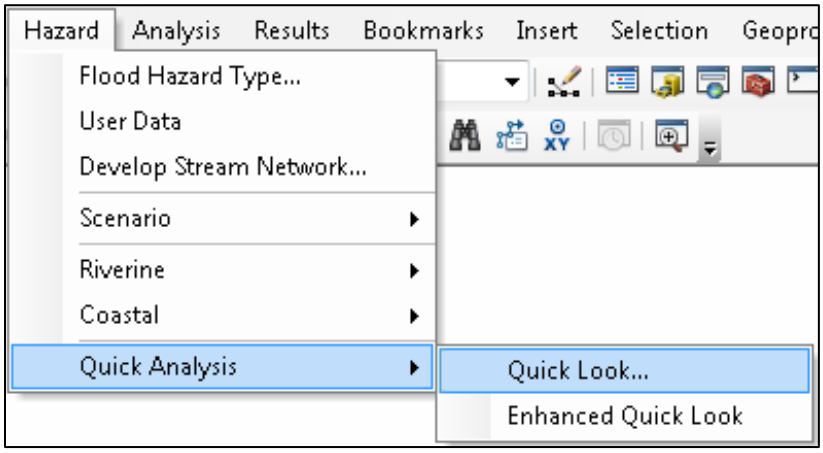
6.6.2 Best Practices and Troubleshooting

Coastal floodplain delineation in the Flood Model is much less likely to have issues than riverine analysis. However, memory issues can still influence a larger coastal analysis. At the bottom of the **Coastal Hazard Analysis** window (Figure 6-76), Hazus indicates how much virtual memory is available on the machine and the estimated virtual memory that will be used for the coastal analysis. When running the coastal flood delineation analysis, the Hazus screen might go blank or the Task Manager **Applications** tab will indicate that Hazus is not responding. This is a common occurrence for any process-heavy software. To see whether Hazus is still running, check the Task Manager **Processes** tab and sort the **CPU** column in descending order. The "ArcMap.exe" process should be on top. If the "System Idle Process" is constantly on top at 99–100%, Hazus is not responding. Also, check the **Performances** tab and make sure the CPU Usage is not 0 over a period of time. Another option is to open the scenario folder (in "Details" view within Windows Explorer) and make sure the FlCoastalLog.txt file is updating by looking at the "Date modified."

6.7 Quick Analysis

The **Hazard / Quick Analysis** menu (Figure 6-77) provides two additional types of low-quality flood analysis: **Quick Look** and **Enhanced Quick Look**. Chapter 13 provides detailed step-by-step instructions on conducting both types of analysis.

Figure 6-77: Select Quick Look



6.7.1 Quick Look

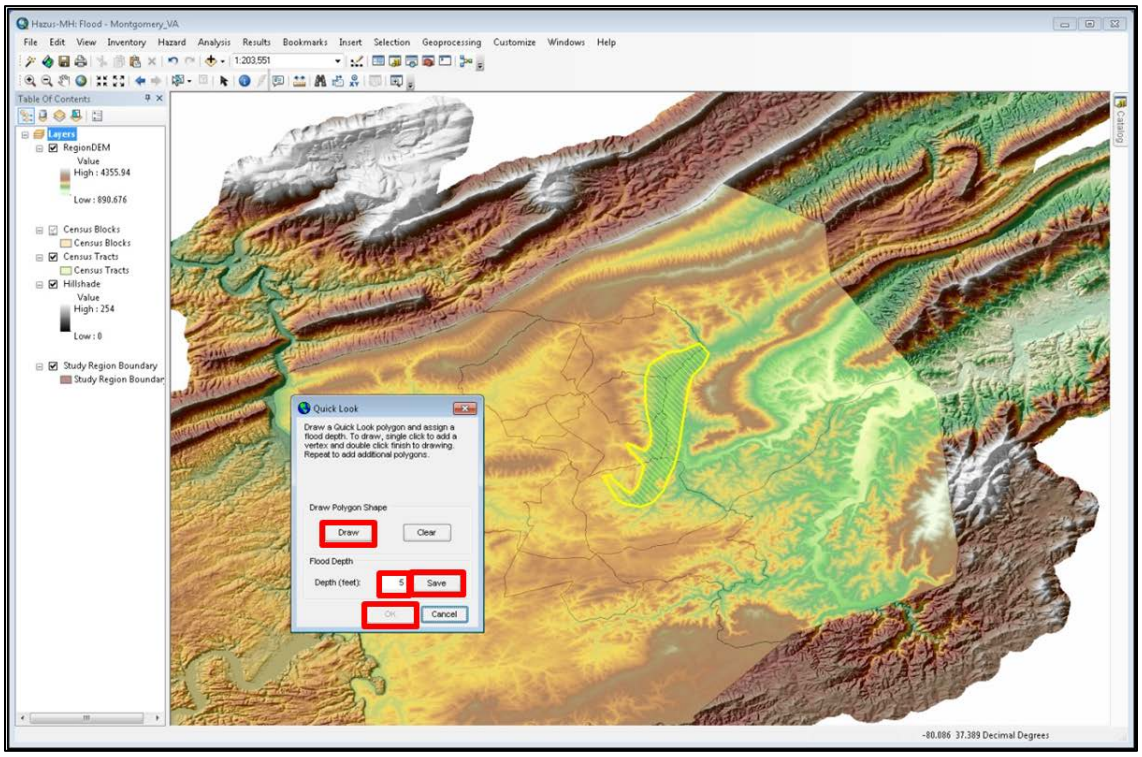
The **Quick Look** feature allows the user to quickly produce a rough estimate of flood damages, without working through the process of generating a stream network or delineating a floodplain. Instead of generating a floodplain associated with a specific return period or rainfall amount, **Quick Look** lets the user enter an anticipated flood depth for an area of their selection. Then, based on the infrastructure present in the area, Hazus estimates approximate damages.

The **Quick Look** analysis is only performed on the GBS. The GBS results tables are populated and a summary report uniquely developed for the **Quick Look** is populated. This restriction was imposed to prevent users from attempting to perform a detailed analysis of a specific site using this crude method of analysis.

Quick Look is only appropriate for small areas with similar elevations. The **Quick Look** function assumes a standard depth of water over the entire area selected, and does not use any topography\DEM or check for the veracity of the flood depths input by the user. If an area with significant elevation gradations has been selected, **Quick Look** will assume that high elevation locations have the same level of flood depth as low elevation locations, which would produce meaningless results. **Quick Look** does allow the user to create multiple polygons with differing flood depths.

To perform a **Quick Look** analysis, select **Quick Look** from the **Hazard / Quick Analysis** menu (Figure 6-77). This functionality will not work if the user has already opened a scenario. Click on **Draw** in the **Quick Look** dialog that appears. Using the cursor, draw a polygon with as many sides as desired, as illustrated with the yellow line in Figure 6-78. Double-click when the polygon is complete. Next, enter a **Flood Depth** for the polygon in the **Quick Look** dialog. Click **Save**, then click **OK**.

Figure 6-78: Drawing a Polygon for Quick Look



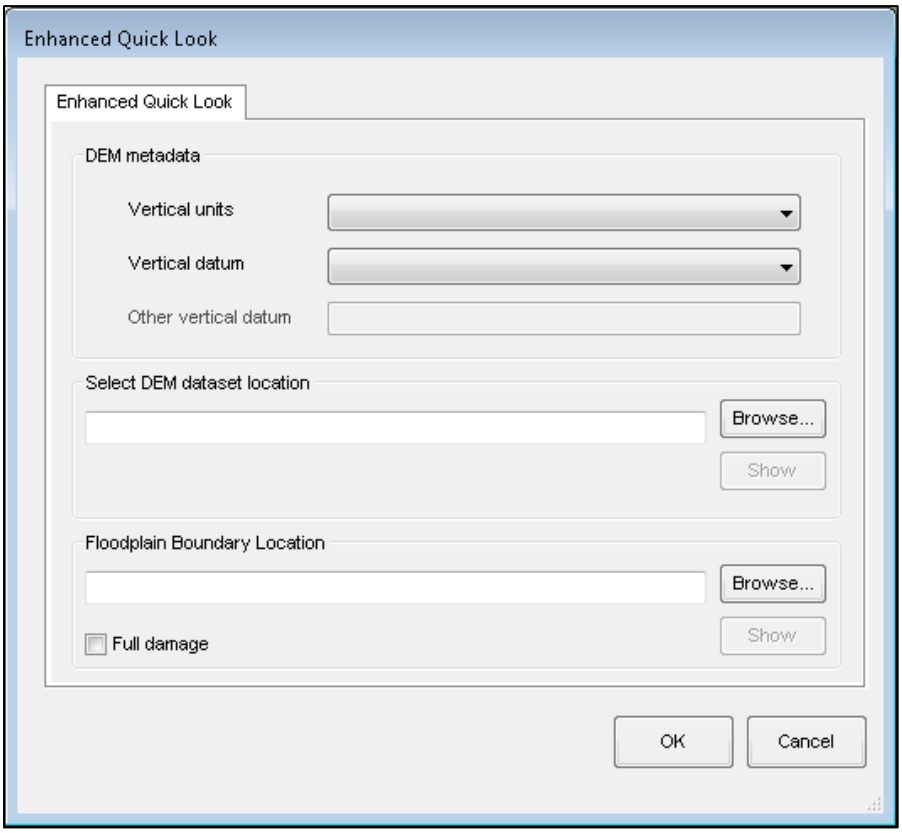
- Only one **Quick Look** analysis can be performed in a given Study Region. Additional **Quick Look** analysis efforts will overwrite the results from the previous analysis. **Quick Look** will not run if a scenario is open. It is independent from the scenario(s).

6.7.2 Enhanced Quick Look

Similar to the **Quick Look** function, the **Enhanced Quick Look** analysis option allows the user to draw a polygon that represents the floodplain boundary and the DEM for the region. Hazus will estimate the flood depth within that boundary. **Enhanced Quick Look** does not establish a flow regime. Therefore, the analysis is based on the user-supplied anecdotal information and should be used with great care.

Select **Enhanced Quick Look** from the **Hazard / Quick Analysis** menu (Figure 6-77). The **Enhanced Quick Look** window will appear (Figure 6-79). Select the **Vertical units** and **Vertical datum** of the polygon from the dropdown menus. Browse to the appropriate locations for the DEM and single continuous floodplain boundary polygon, as illustrated in Figure 6-79. Click **OK** to start the analysis.

Figure 6-79: Enhanced Quick Look Window



Only one **Enhanced Quick Look** analysis can be performed in a given Study Region. Additional **Enhanced Quick Look** analysis efforts will overwrite the results from the previous analysis. **Enhanced Quick Look** will not run if a scenario is open. It is independent from the scenario(s).

The **Enhanced Quick Look** analysis is only performed on the GBS. The GBS results tables are populated and a summary report uniquely developed for the **Enhanced Quick Look** is populated. This restriction was imposed to prevent users from attempting to perform a detailed analysis of a specific site using this crude method of analysis.

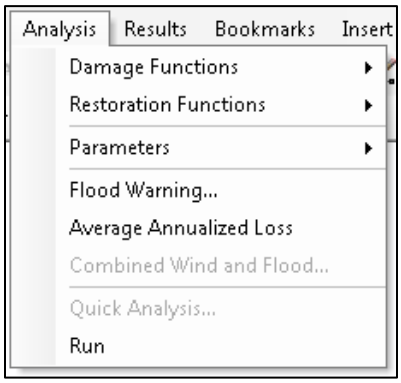
See Chapter 13 for step-by-step instructions on how to perform **Quick Look** and **Enhanced Quick Look** analyses.

7 Model Menu: Analysis

After Hazus has calculated the hazards, it will need to run the loss analysis to provide damage estimates using the **Analysis** menu (Figure 7-1). As with other Hazus Flood Model menus, items grayed out represent functionality not currently available given the type of analysis being conducted and the completion of required prerequisite analysis steps.

In a Hazus loss analysis, the characteristics of the structures and people of the Study Region are analyzed for vulnerability to the flood or floods that have been calculated in the scenario. Default depth damage functions, which estimate percent damage relative to the depth of floodwater as measured from the top of the first finished floor (riverine) or bottom of the first floor (coastal), are provided within the Hazus program. Other damage functions are also included in the Flood Model to estimate damages to vehicles, agriculture, utility components, and transportation bridges.

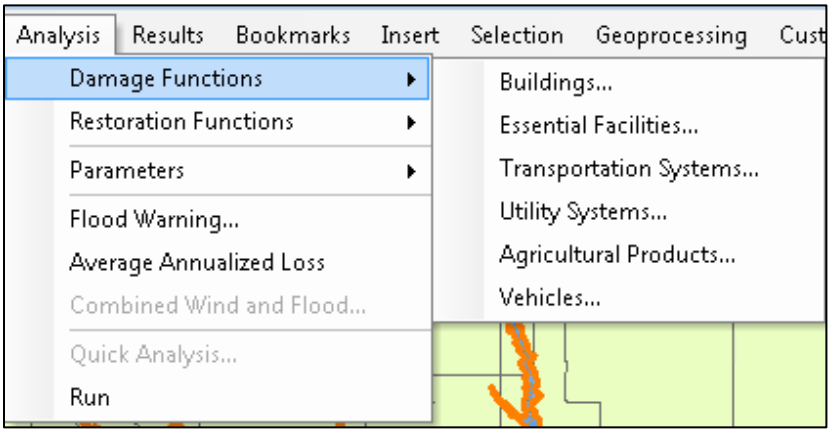
Figure 7-1: Analysis Menu



7.1 Damage Functions

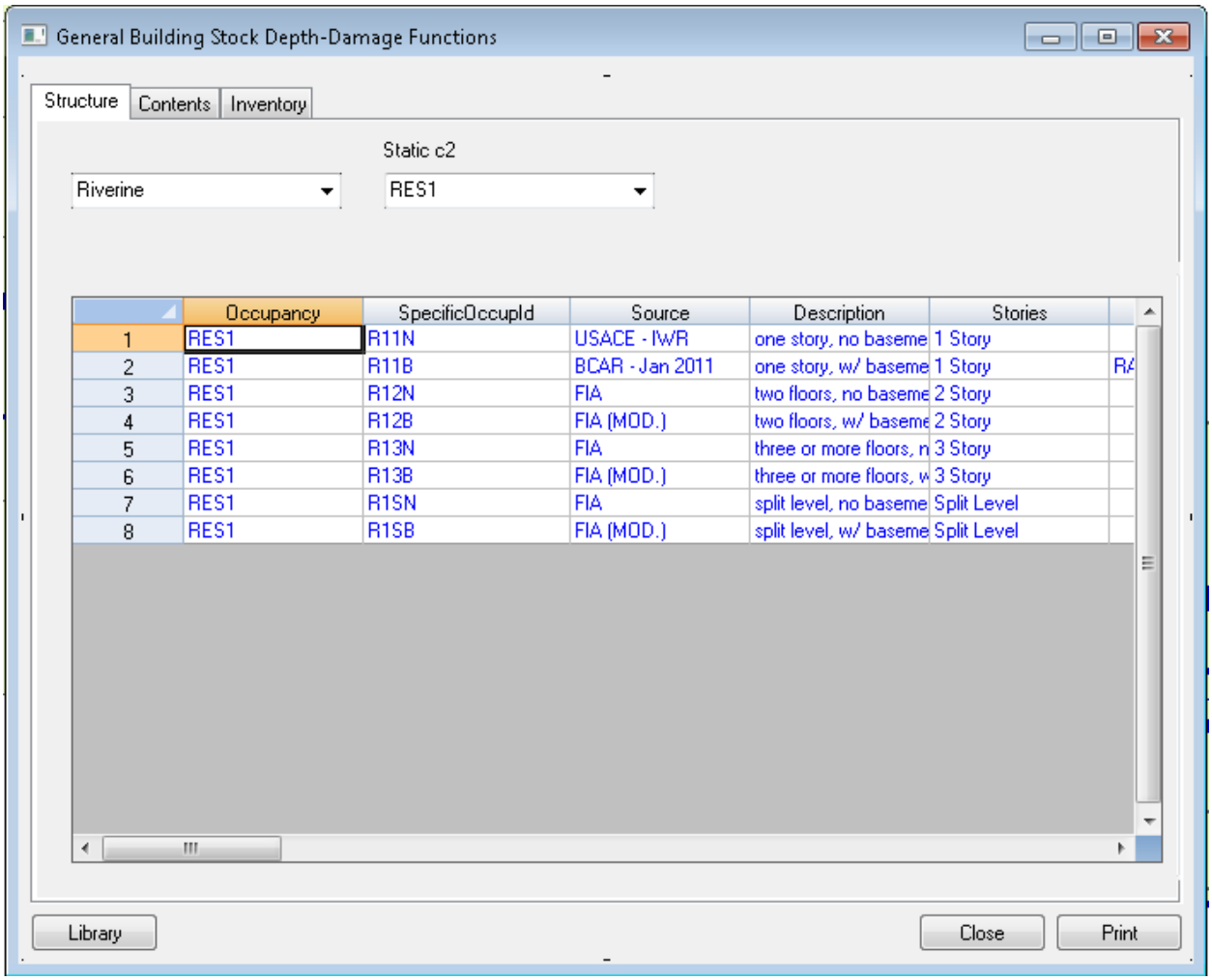
The **Analysis** menu options reflect the functions that will be used to estimate damage of various types. This section discusses the options on the **Analysis / Damage Functions** menu.

Figure 7-2: Analysis / Damage Functions Menu



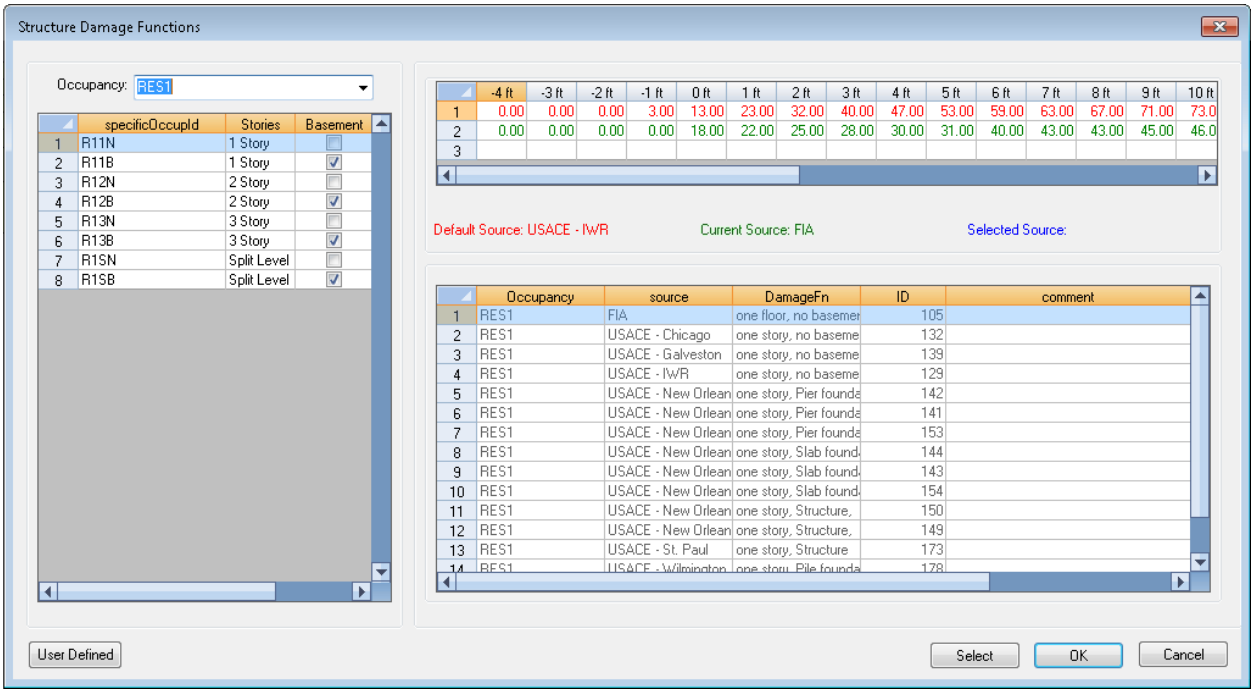
Select **Buildings** from **Analysis / Damage Functions** menu. The **General Building Stock Depth-Damage Functions** table shown in Figure 7-3 will appear. The **Structure** table provides information on the default damage function associated with each specific occupancy class (e.g., RES1) and subclass (e.g., RES1, 1 story, no basement). Scroll to the right to see the percent of damage, expressed in terms of building replacement cost, estimated at different water depths. The pull-down menus at the top of the window allow the user to view the default damage functions for the flood hazard types (V zone, coastal A zone, and riverine) and other occupancy classes (e.g., COM1, AGR1, IND1). Click on the different tabs at the top (**Structure**, **Contents**, **Inventory**) to view default damage functions associated with building structures, and their contents, for all specific occupancy types and inventory for selected occupancies (e.g.,COM1, IND1-6, AGR1).

Figure 7-3: Building Depth-Damage Functions by Occupancy (Riverine) Table



Click on the **Library** button in the lower left corner of the **Building Stock Depth-Damage Functions** window. The **Structure Damage Functions** library shown in Figure 7-4 will appear. Viewing the library of damage functions allows the user to review other damage functions applicable to the occupancy under consideration relative to the current default, as well as replace the current default with another function from the library.

Figure 7-4: Building Depth-Damage Function Library



The Library uses color codes to help the user identify any changes and selections they may make in the dialog. The Library dialog comprises three windows.

The left window is the navigation window where the user can change between occupancies, foundation heights, and number of stories. This window allows the user to select a specific occupancy (e.g., RES1) and shift through the potential foundation types (slab on grade, fill, basement, crawlspace, pier, post, and pile) and number of stories typical for the selected specific occupancy (1 story, 2 story, 3 story, split level for residential and low-, mid-, and high-rise for non-residential) within that occupancy. The sub-occupancies displayed in the window (shown in the first column) are a form of shorthand that identifies the occupancy class. The short hand was developed by taking the first letter and numeric values of the specific occupancy name (e.g., RES1 becomes R1 and COM10 become C10); this is concatenated with the value for the number of stories (e.g., 2 story becomes 2 and low rise becomes L), and finally the existence of a basement derives the last value (e.g., structures with a basement get a B and structures without a basement get an N). Therefore, the residential occupancy classified as RES1 with 1 story and no basement becomes R11N while the commercial occupancy classified as COM10, mid-rise, with a basement becomes C10MB.

The bottom right window is where the library of damage functions is displayed for the user to view and/or select. The user can browse between damage functions for the foundation and number of stories by selecting the sub-occupancies in the left column grid. In this case, Figure

7-4 displays all of the functions available for the sub-occupancy R11N (RES1, 1 Story, with no basement). Selection of C10MB (COM10, mid-rise, with basement) would display an entirely different set of damage functions in the grid on the lower right.

Finally, the window in the upper right allows the user to make comparisons and selections among the damage functions. The first row in the grid will always display the Hazus default function in red. The second line in the upper right grid displays the “current” function or any damage function that the user has highlighted in the lower window. To help the user view the current function, it is also displayed in green text. The user may want to use the “current function” line as a way of displaying a function and directly comparing it to the default damage function. Figure 7-4 displays a U.S. Army Corps of Engineers (USACE) New Orleans District damage function (highlighted row 10) for RES1, 1 story, slab on grade. The third row in the upper right grid displays any function the user may have “selected” as their damage function. That is, a damage function the Flood Model will use rather than the default damage function. This is how the user can override the default damage functions with either a library function that they believe better represents the local area or a custom function they have built themselves as described below.

Figure 7-5 displays a USACE New Orleans District damage function (lower right grid, blue text RES1, 1 story, pier foundation) that was selected in place of the default function. If the user chooses, they may use one of the library functions to build their own custom damage function. To do this, click the **User Defined** button in the lower left corner of the dialog. When the user selects this button, the Flood Model takes the highlighted damage function, if any, and opens an editable dialog (Figure 7-6) for the user to make modifications. The Flood Model inserts the damage function description from the starting damage function the user selected (or the default damage function if none is selected) and adds a comment that identifies the original source damage function. This allows the user to remember where they started the process. The user is required to enter a source (or name) for the damage function. Editing of the **Enter Comment** or **Enter DmgFn Description** fields is not recommended.

Figure 7-5: Building Depth-Damage Function Library User-Defined Option

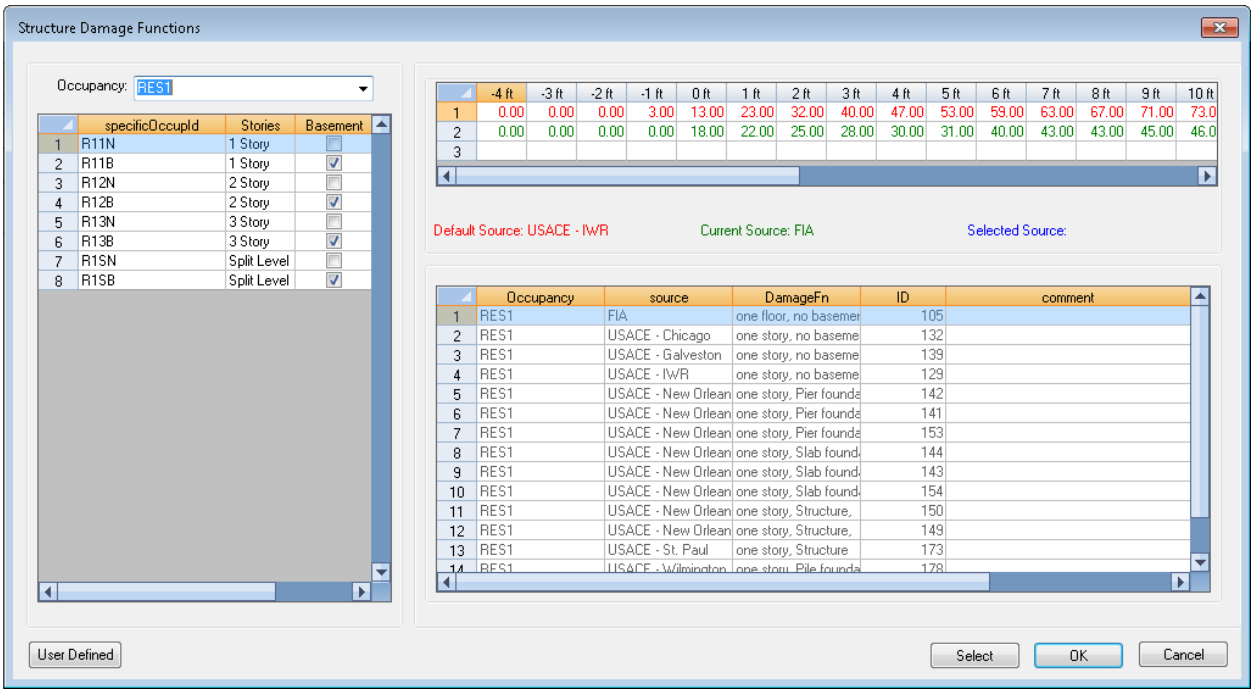
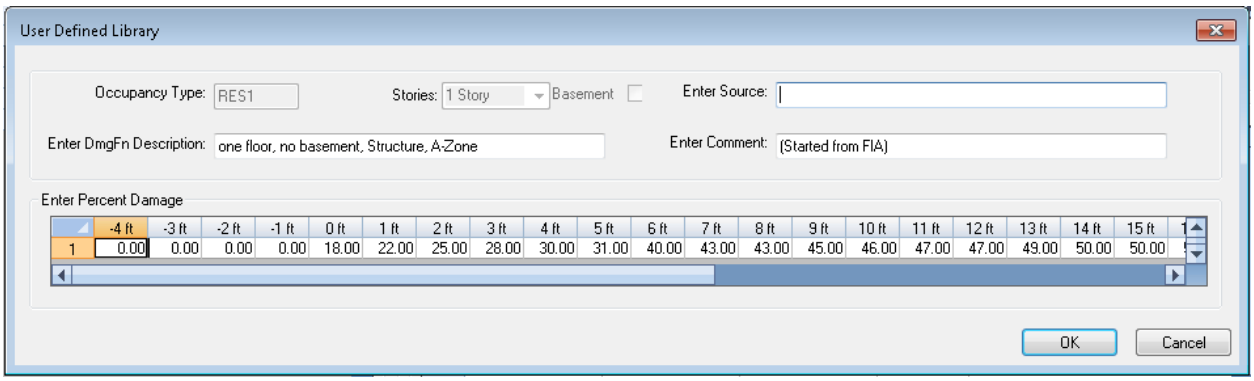
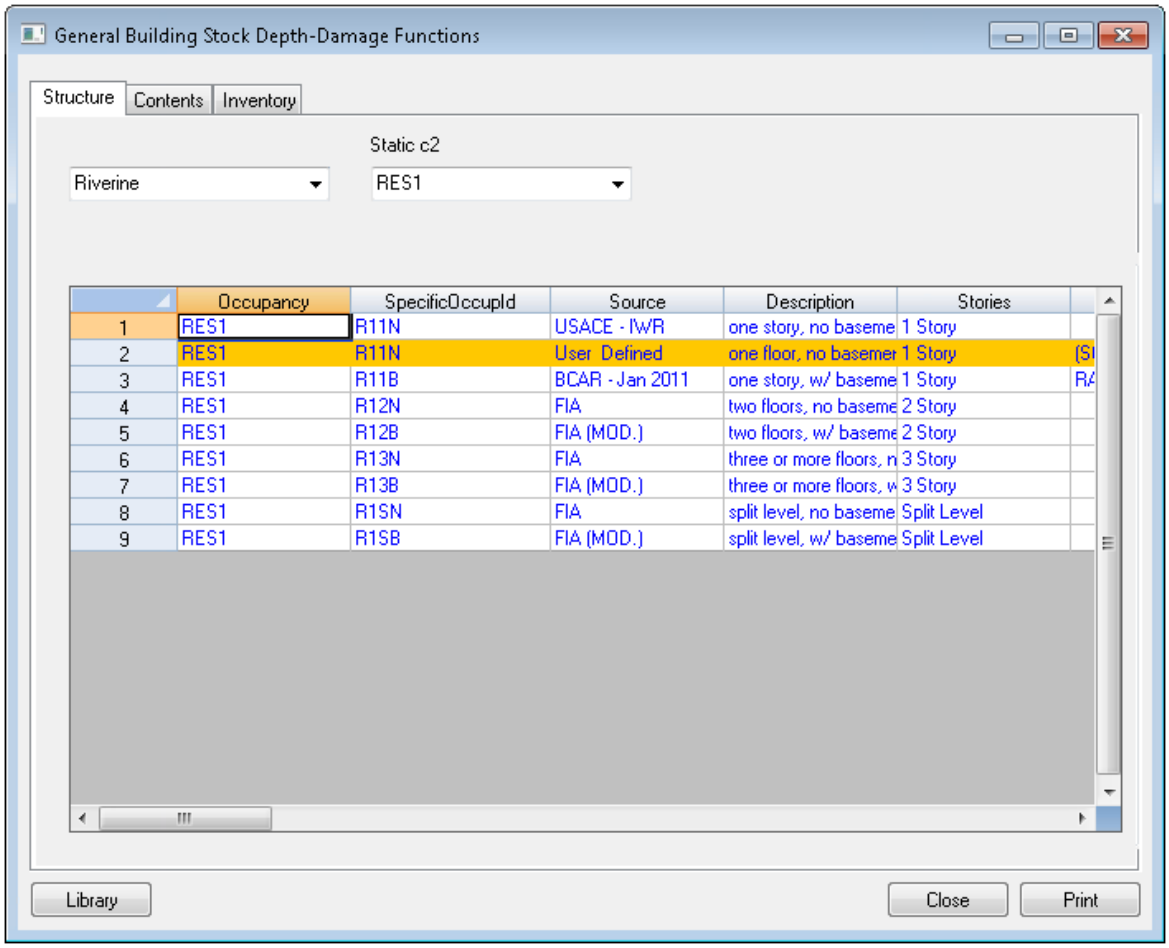


Figure 7-6: Editing Dialog for User-Defined Function Development



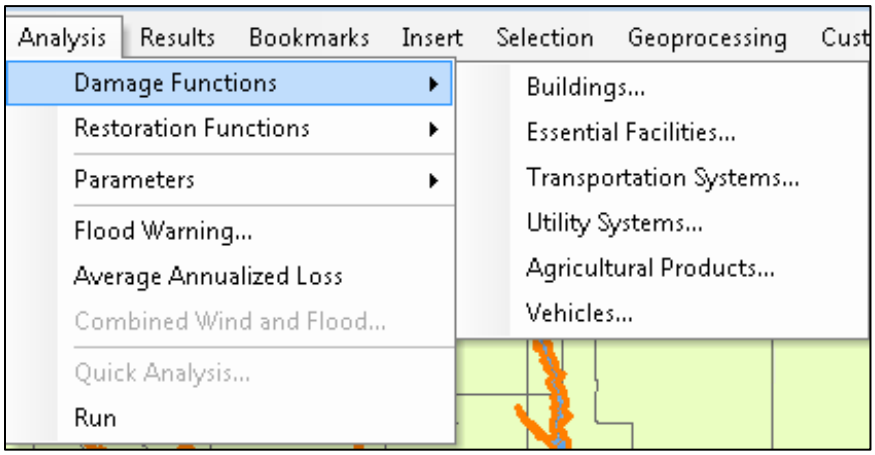
If the user has decided to select a new damage function for use in the Flood Model, the entry dialog will highlight the damage function to remind the user that a default function is not being used. Figure 7-7 shows how the change would appear in the entry dialog as compared to that shown earlier in this section in Figure 7-3 using a User-Defined Depth-Damage Function.

Figure 7-7: Building Depth-Damage Function Dialog with a User-Defined Damage Function



Similar default damage functions are available for other facilities from the **Damage Functions** menu, as shown in Figure 7-8 below. The damage function dialogs for **Essential Facilities** function in the same way as those discussed above for the **General Building Stock**. In most cases, the damage functions available in the **Essential Facilities** dialog area also available for the Government structures in GBS. The **Essential Facilities** dialog does not have an inventory tab because the Essential Facilities occupancies do not produce inventory for sale.

Figure 7-8: Analysis / Damage Functions Menu

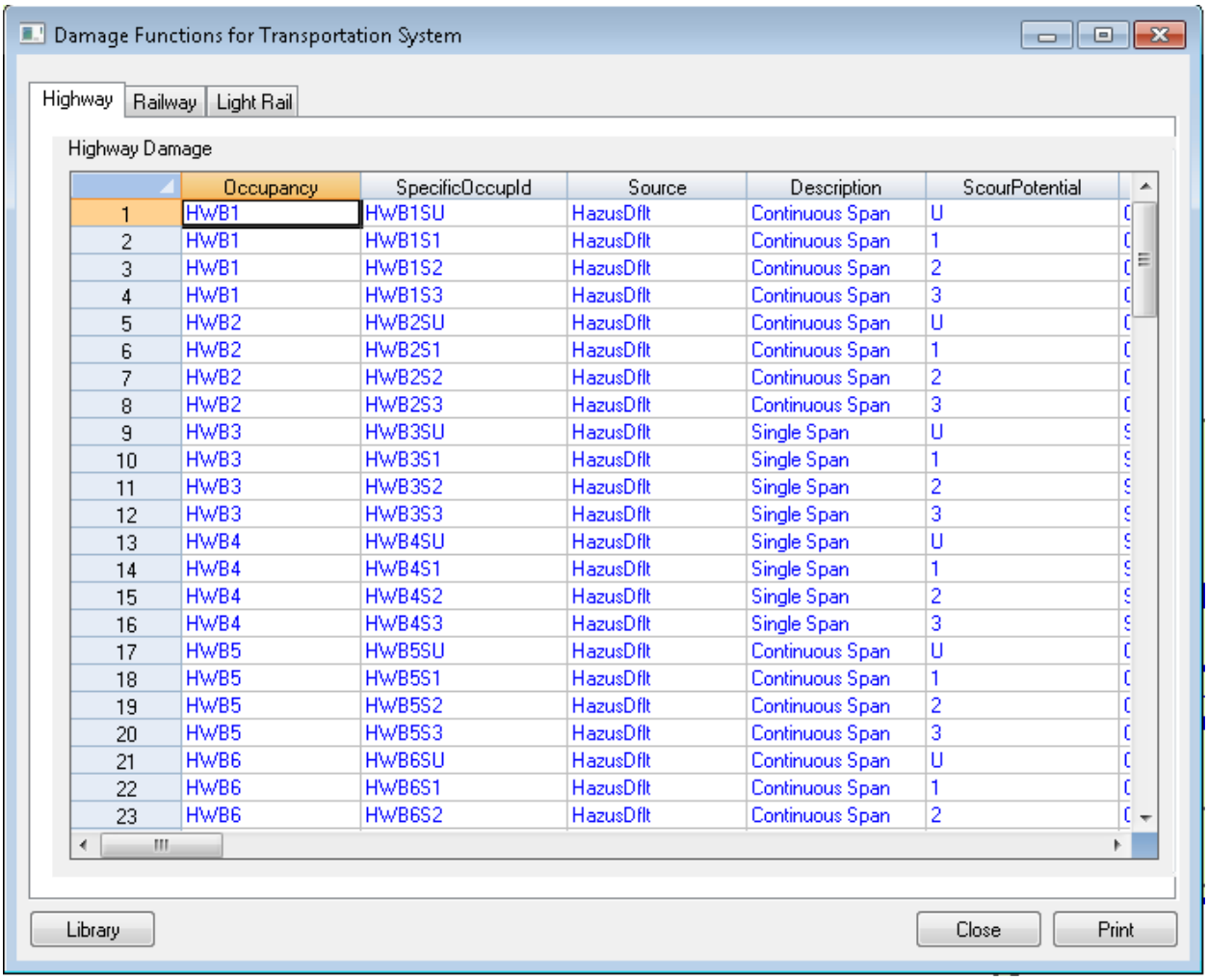


The **Transportation Systems** damage function dialog looks slightly different as there is only a structure damage function (no contents or inventory) and the dialogs tabs allow the user to shift between highway, railway, and light rail facilities.

- Currently, the Flood Model has damage functions for bridges only related to highway, railway, and light rail facilities.
- The **Transportation Systems** damage functions for bridges are based on return period. An analysis cannot be performed on bridges if the user assigns mixed return periods on the selected reaches. In other words, if the user assigns a different return period to each reach, or a single discharge on the reaches, the Flood Model will not be able to analyze the bridges.

Figure 7-9 shows the **Damage Functions for Transportation System** table, which has the same table columns for highway, railway, and light rail facilities.

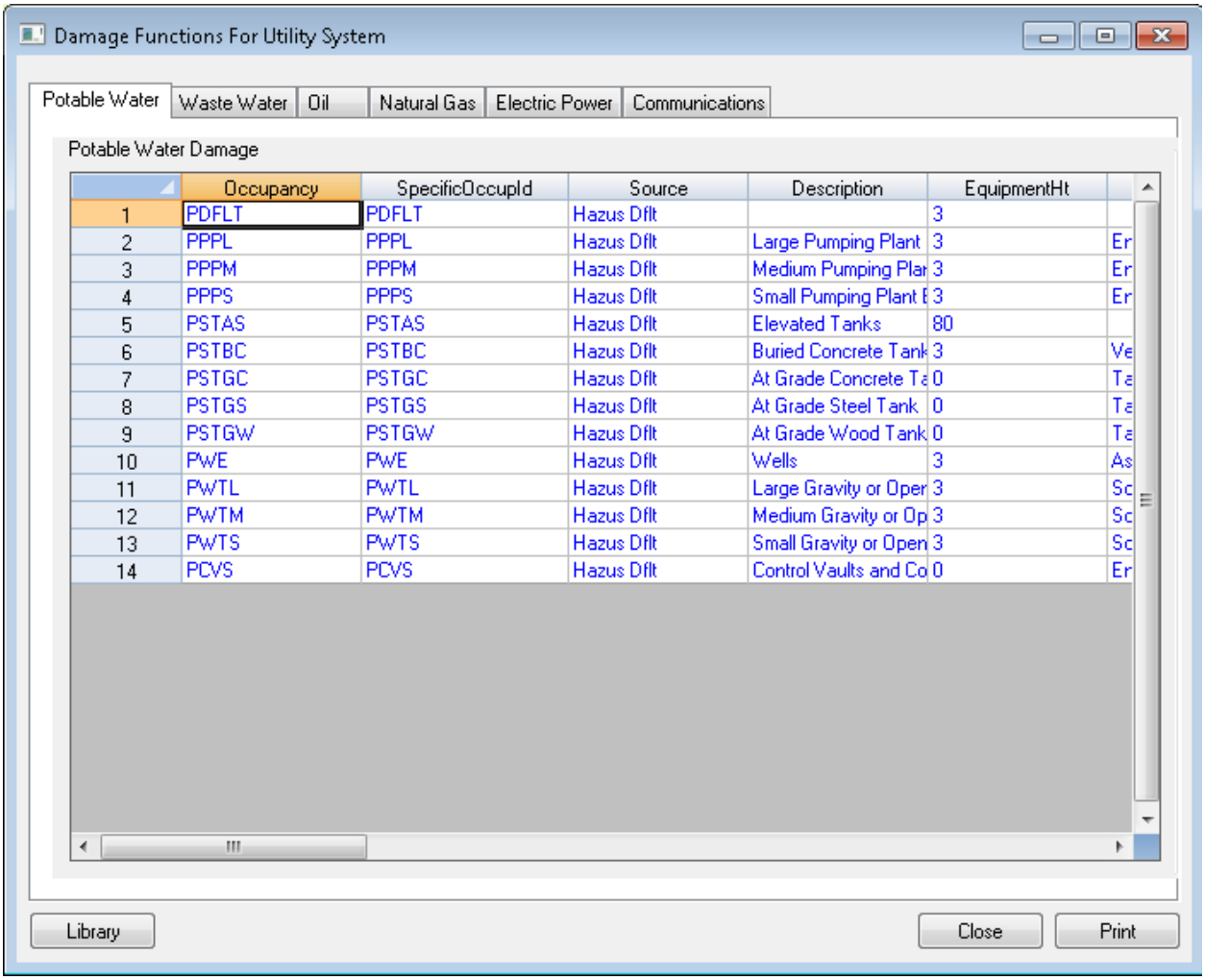
Figure 7-9: Transportation Damage Function Table



	Occupancy	SpecificOccupId	Source	Description	ScourPotential
1	HWB1	HWB1SU	HazusDflt	Continuous Span	U
2	HWB1	HWB1S1	HazusDflt	Continuous Span	1
3	HWB1	HWB1S2	HazusDflt	Continuous Span	2
4	HWB1	HWB1S3	HazusDflt	Continuous Span	3
5	HWB2	HWB2SU	HazusDflt	Continuous Span	U
6	HWB2	HWB2S1	HazusDflt	Continuous Span	1
7	HWB2	HWB2S2	HazusDflt	Continuous Span	2
8	HWB2	HWB2S3	HazusDflt	Continuous Span	3
9	HWB3	HWB3SU	HazusDflt	Single Span	U
10	HWB3	HWB3S1	HazusDflt	Single Span	1
11	HWB3	HWB3S2	HazusDflt	Single Span	2
12	HWB3	HWB3S3	HazusDflt	Single Span	3
13	HWB4	HWB4SU	HazusDflt	Single Span	U
14	HWB4	HWB4S1	HazusDflt	Single Span	1
15	HWB4	HWB4S2	HazusDflt	Single Span	2
16	HWB4	HWB4S3	HazusDflt	Single Span	3
17	HWB5	HWB5SU	HazusDflt	Continuous Span	U
18	HWB5	HWB5S1	HazusDflt	Continuous Span	1
19	HWB5	HWB5S2	HazusDflt	Continuous Span	2
20	HWB5	HWB5S3	HazusDflt	Continuous Span	3
21	HWB6	HWB6SU	HazusDflt	Continuous Span	U
22	HWB6	HWB6S1	HazusDflt	Continuous Span	1
23	HWB6	HWB6S2	HazusDflt	Continuous Span	2

Figure 7-10 shows the **Damage Functions For Utility System** table. As with the **Transportation Systems**, the tabs allow the user to choose the utility type for review.

Figure 7-10: Utility Facility Damage Function Table

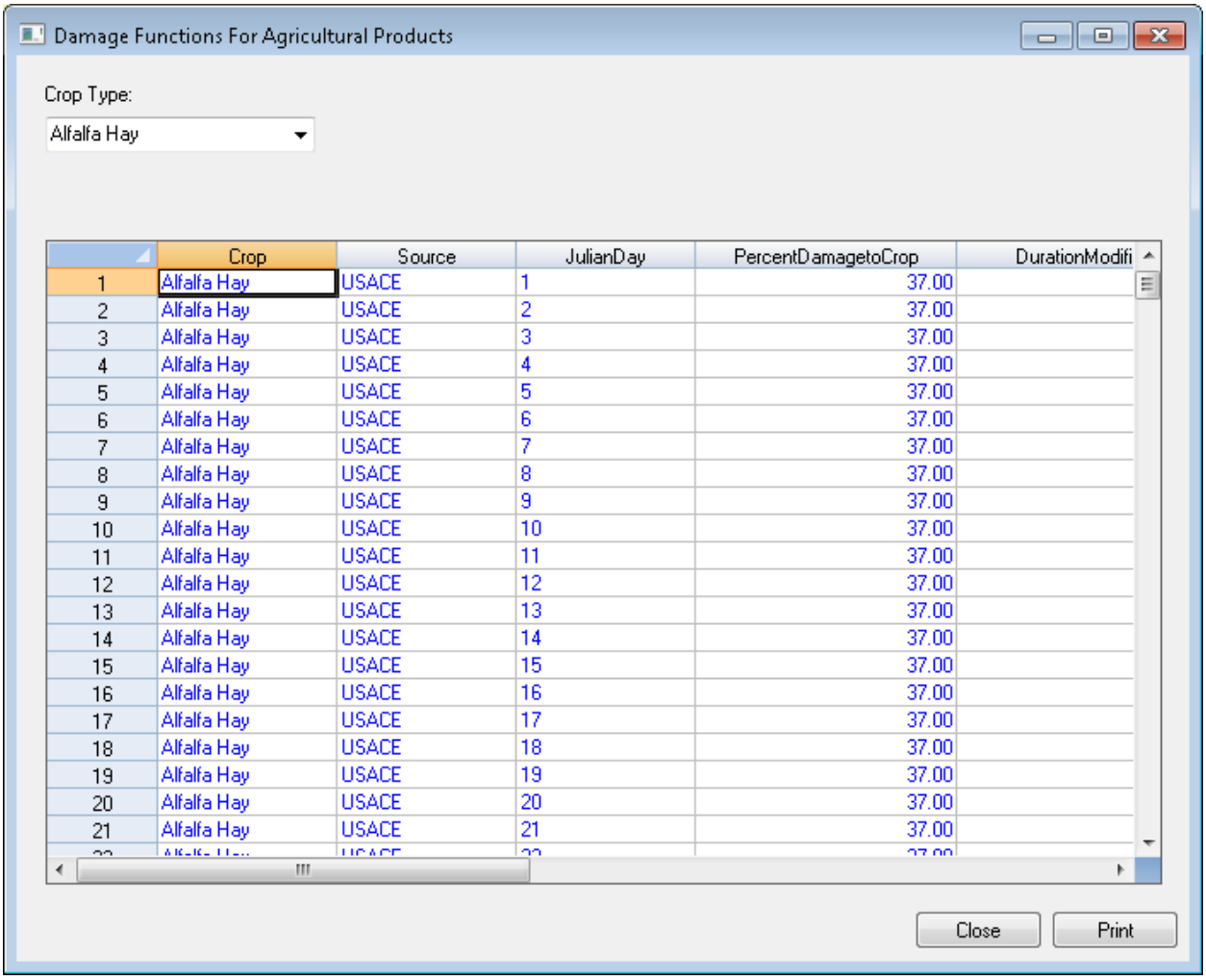


The **Damage Functions For Agriculture Products** table shown in Figure 7-11 is similar to the **General Building Stock Depth-Damage Function** table, but has been modified to support the different crops available to the user. The Flood Model team gathered a number of damage functions from the USACE for various crops. The total number of damage functions available were limited and in some cases functions had to be created to allow the users to work with the top agricultural crops within each state. The damage functions are based on a Julian calendar system. For the user's convenience, the Flood Model makes the conversion between the standard calendar day and month to the Julian date. The user must provide the date either in the **Analysis** / **Parameters** / **Agricultural** menu or in a popup window after the agricultural analysis has been started. This process is described in Section 7.3.

The Flood Model assumes a short duration, slow rise flood when analyzing losses. Agriculture crops are particularly sensitive to duration and the functions obtained from the USACE have

damage modifiers (visible by scrolling to the right) that allow for the estimation of flood damages should the flood last 0 days, 3 days, 7 days, and 14 days. The damage functions defaults in the Flood Model assume that the maximum damage is obtained at the 14-day interval.

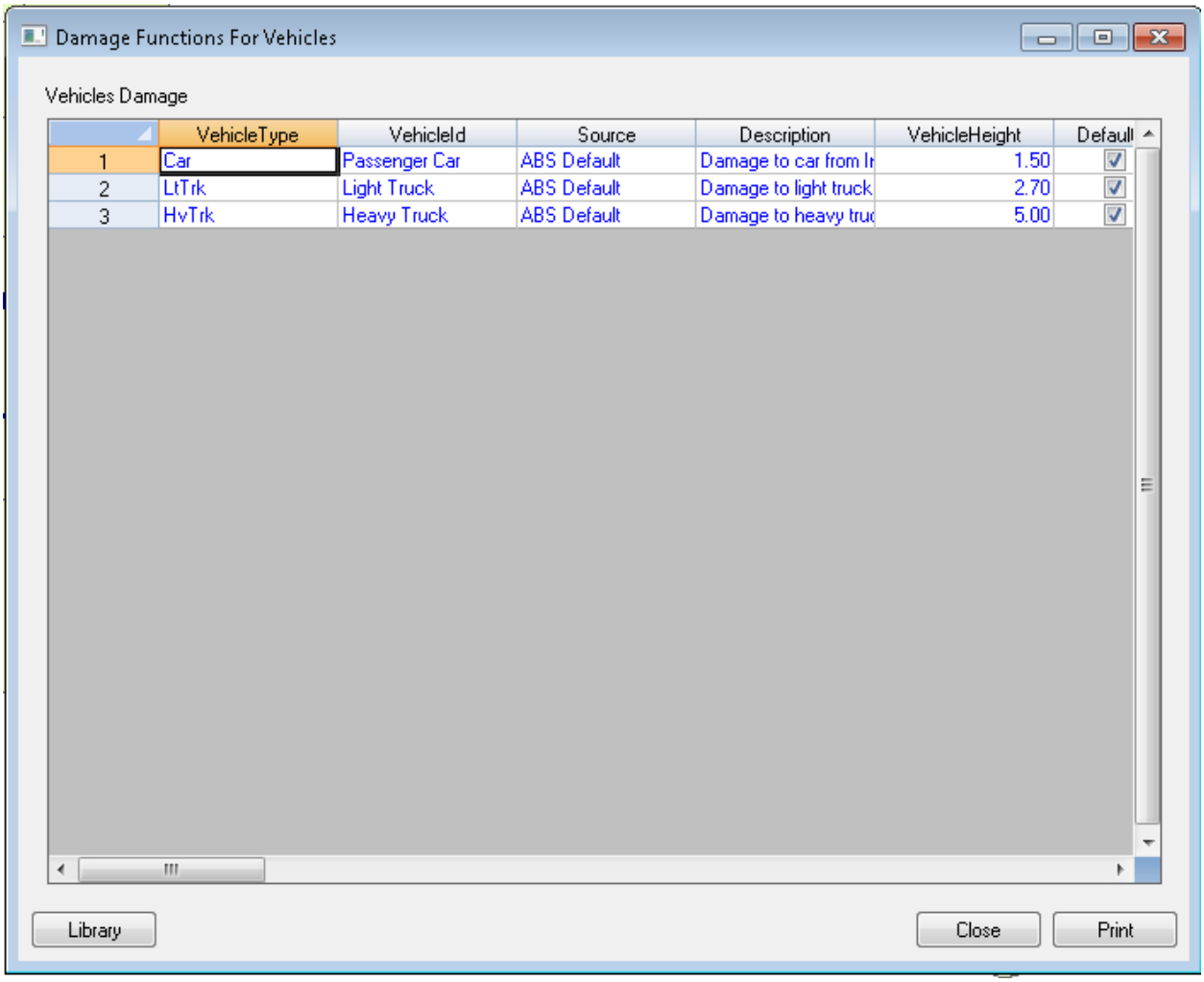
Figure 7-11: Agriculture Products Damage Function Table



	Crop	Source	JulianDay	PercentDamagetoCrop	DurationModifi
1	Alfalfa Hay	USACE	1	37.00	
2	Alfalfa Hay	USACE	2	37.00	
3	Alfalfa Hay	USACE	3	37.00	
4	Alfalfa Hay	USACE	4	37.00	
5	Alfalfa Hay	USACE	5	37.00	
6	Alfalfa Hay	USACE	6	37.00	
7	Alfalfa Hay	USACE	7	37.00	
8	Alfalfa Hay	USACE	8	37.00	
9	Alfalfa Hay	USACE	9	37.00	
10	Alfalfa Hay	USACE	10	37.00	
11	Alfalfa Hay	USACE	11	37.00	
12	Alfalfa Hay	USACE	12	37.00	
13	Alfalfa Hay	USACE	13	37.00	
14	Alfalfa Hay	USACE	14	37.00	
15	Alfalfa Hay	USACE	15	37.00	
16	Alfalfa Hay	USACE	16	37.00	
17	Alfalfa Hay	USACE	17	37.00	
18	Alfalfa Hay	USACE	18	37.00	
19	Alfalfa Hay	USACE	19	37.00	
20	Alfalfa Hay	USACE	20	37.00	
21	Alfalfa Hay	USACE	21	37.00	

Figure 7-12 shows the **Damage Functions For Vehicles** table.

Figure 7-12: Vehicle Damage Functions Table



7.2 Restoration Functions

The Flood Model provides restoration functions for GBS and Essential Facilities. The GBS restoration functions are discussed in the **Analysis / Parameters** menu discussion, as the GBS values are included in the **Direct Economic** parameter tables. Built from the restoration timelines for the related GBS occupancies, the Essential Facilities restoration models provide the user with a general indication of the *maximum* restoration time for 100 percent operations. Obviously, there will be a great deal of effort to quickly restore Essential Facilities to full functionality and therefore this will be an indication of the maximum downtime.

Selecting **Essential Facilities** from the **Analysis / Restoration Functions** menu (Figure 7-13) opens the dialog shown in Figure 7-14. In this case, the figure shows the dialog on the **Medical Care Facilities** tab. The **Restoration Functions** are editable and the user can adjust the

MaxDaysToRestoration column and the **FunctionalDepth** column (scroll to the right). These values are based on the depth of flooding at the specific facility (the latitude and longitude).

Figure 7-13: Analysis / Restoration Functions Menu

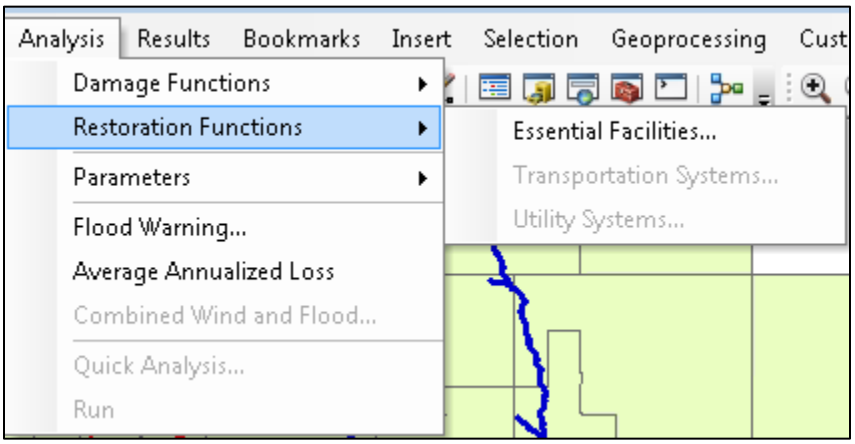
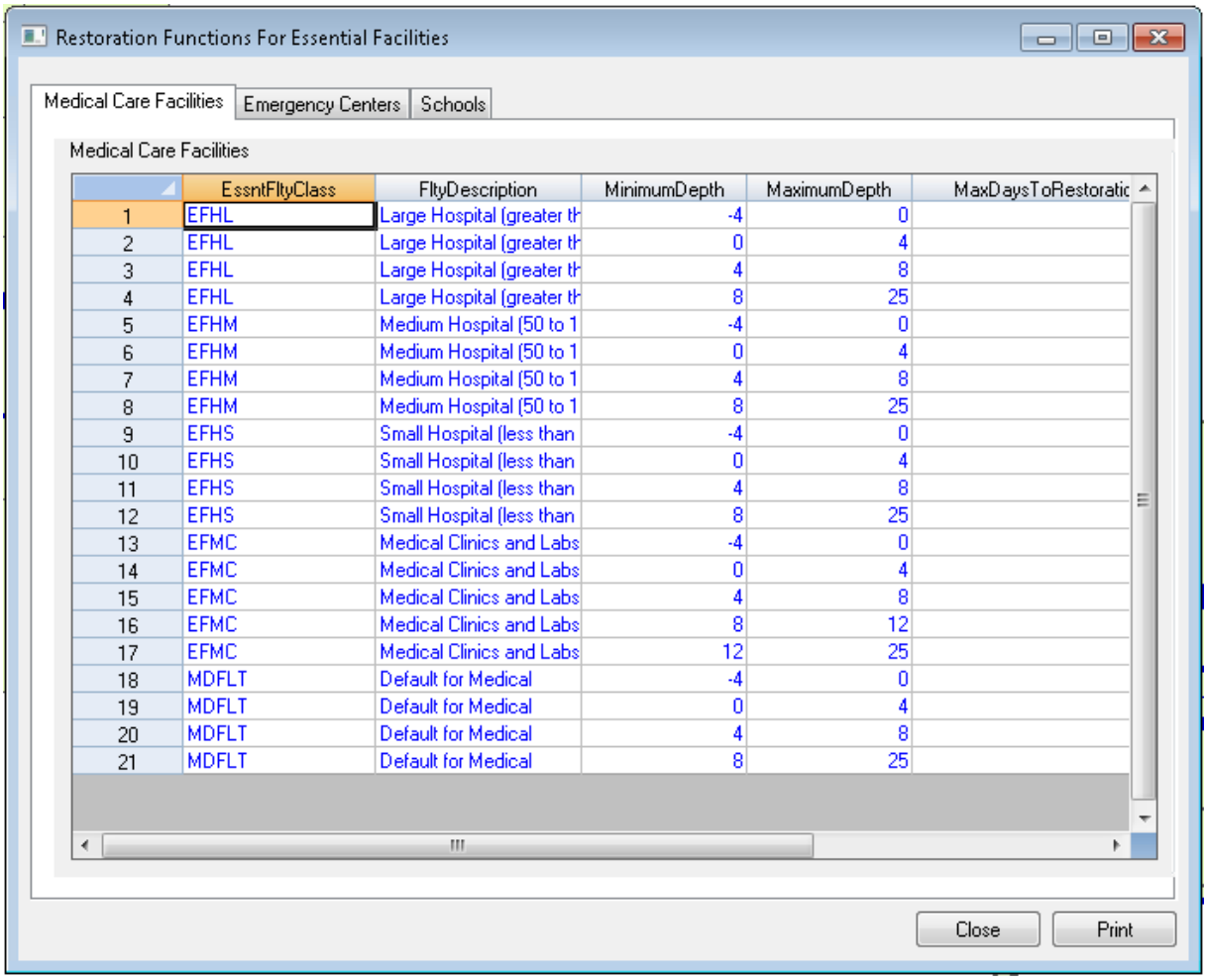


Figure 7-14: Essential Facilities Restoration Functions Table



	EssntFltyClass	FltyDescription	MinimumDepth	MaximumDepth	MaxDaysToRestoratic
1	EFHL	Large Hospital (greater th	-4	0	
2	EFHL	Large Hospital (greater th	0	4	
3	EFHL	Large Hospital (greater th	4	8	
4	EFHL	Large Hospital (greater th	8	25	
5	EFHM	Medium Hospital (50 to 1	-4	0	
6	EFHM	Medium Hospital (50 to 1	0	4	
7	EFHM	Medium Hospital (50 to 1	4	8	
8	EFHM	Medium Hospital (50 to 1	8	25	
9	EFHS	Small Hospital (less than	-4	0	
10	EFHS	Small Hospital (less than	0	4	
11	EFHS	Small Hospital (less than	4	8	
12	EFHS	Small Hospital (less than	8	25	
13	EFMC	Medical Clinics and Labs	-4	0	
14	EFMC	Medical Clinics and Labs	0	4	
15	EFMC	Medical Clinics and Labs	4	8	
16	EFMC	Medical Clinics and Labs	8	12	
17	EFMC	Medical Clinics and Labs	12	25	
18	MDFLT	Default for Medical	-4	0	
19	MDFLT	Default for Medical	0	4	
20	MDFLT	Default for Medical	4	8	
21	MDFLT	Default for Medical	8	25	

7.3 Parameters

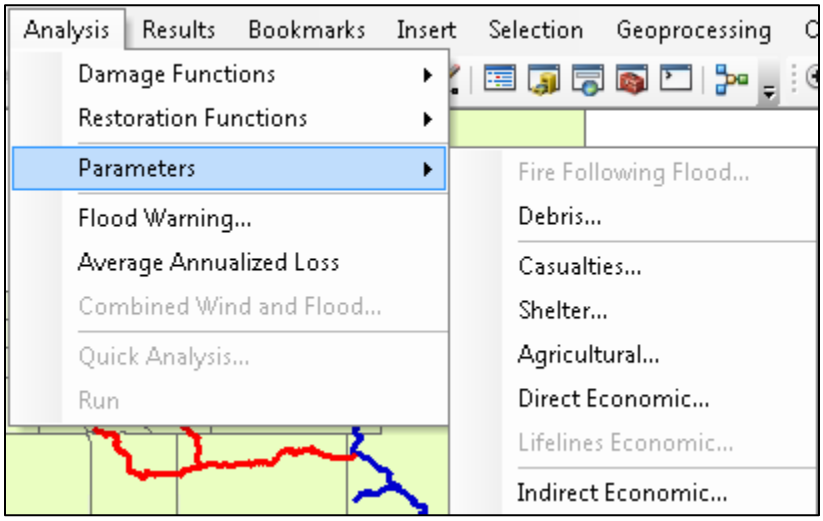
There are several parameters the user may want to view and/or modify before starting the analysis. In one case, **Agriculture**, the user is required to input a value before the Flood Model can perform the analysis. This section walks the user through the available parameters. Every effort has been made to provide default values wherever possible, which allow the model to perform most requested analysis without user intervention.

The **Analysis / Parameters** menu appears in Figure 7-15. The menu provides access to the default parameters used in the analysis of **Fire Following Flood**, **Debris**, **Casualties**, **Shelter**, **Agriculture**, **Direct Economic**, **Lifelines Economic**, and **Indirect Economic**.

The **Casualties** menu item opens a word document that provides the user with some guidance on the natural average for casualties. The Flood Model does not provide estimates for flood-related casualties.

The **Fire Following Flood**, **Lifelines Economic**, and **Indirect Economic** analyses are all currently inactive in Hazus and will not be described in this version of the user manual.

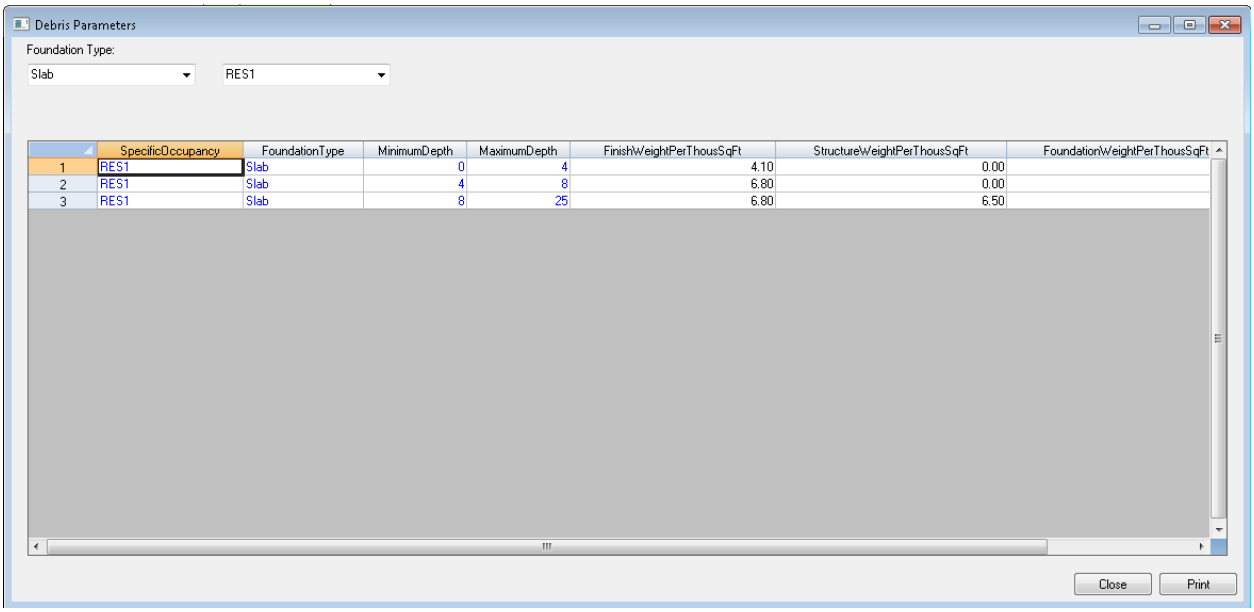
Figure 7-15: Analysis / Parameters Menu



Selection of the **Debris** menu item opens an editable **Debris Parameters** dialog (Figure 7-16) that allows the user to view the default debris values. Debris is estimated based on the depth of flooding within the structure, similar to the estimation of GBS damage, specific occupancy, and whether the foundation has a footing or a slab. The user can use the combo boxes to shift between specific occupancies and the foundation types.

Debris is estimated in three main classifications that align loosely with the earthquake models method of classification: finishes (dry wall, flooring, insulation, etc.), structure (framing, walls, exterior cladding), and foundation weight (concrete slab, concrete block, or other foundation). Unlike the earthquake model, where moderate damage may still result in the foundation being removed, flooding requires the structure to be considered substantially damaged before the foundation is removed. The weights are in tons per thousand square feet of the structure.

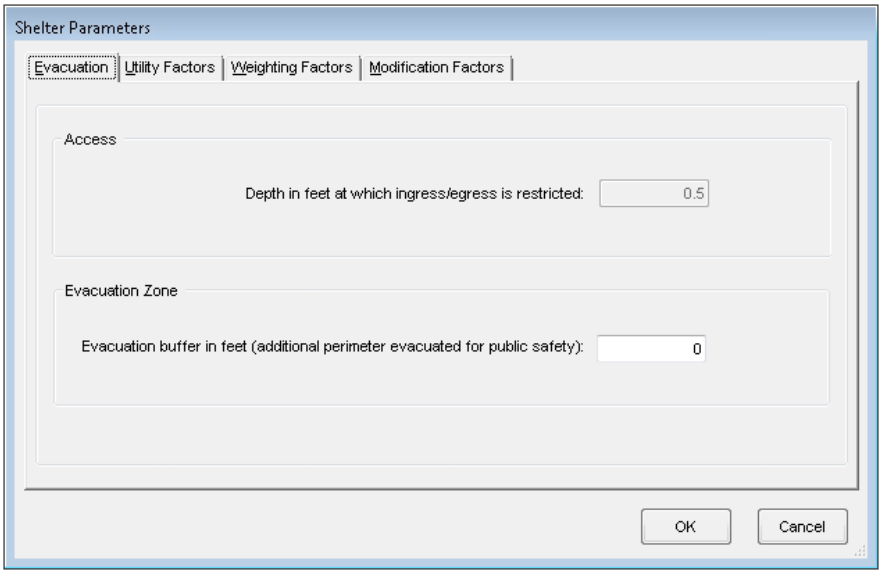
Figure 7-16: Debris Analysis Parameters Table



The **Shelter** menu item opens the **Shelter Parameters** dialog (Figure 7-17), which has multiple tabs and provides access to the various parameters that affect the number of people who are evacuated (displaced) and the number of people who require short-term sheltering. Because the Flood Model does not address flooding, such as flash flooding or long-duration flooding, Hazus assumes that the local authorities will have time to alert the residents and evacuate directly from the areas that will flood. This means any portion of a census block that is flooded initially is assumed to have all of the residents removed from the area. Ultimately, the level of damage within the GBS and the characteristics of the population will determine how many people require short-term sheltering.

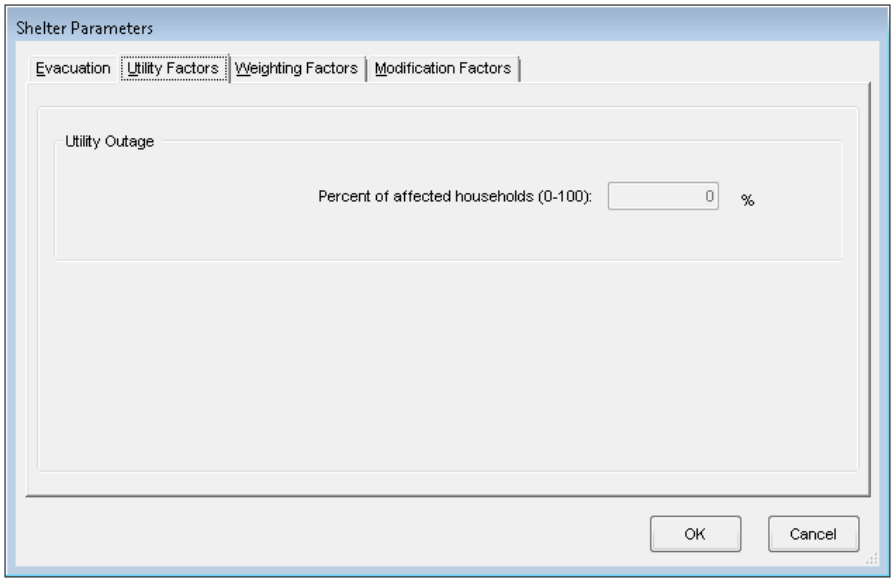
The first tab shown in Figure 7-17, **Evacuation**, allows the user to modify the **Evacuation buffer in feet**, which will have a direct impact on the results. This value is a buffer the Flood Model will add to the current floodplain polygon. In essence, this value will increase the floodplain polygon by the distance input by the user, such as 500 feet. The model will then estimate the total population within the floodplain boundary and the buffer to identify the displaced population.

Figure 7-17: Shelter Evacuation Parameter Dialog



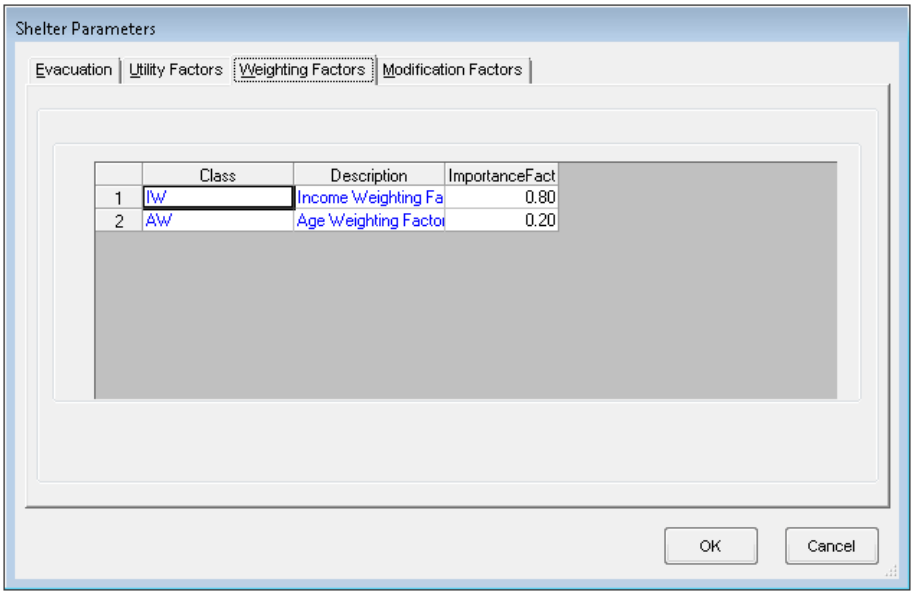
The **Utility Factors** tab includes a field for **Utility Outage**, which is used in the determination of the short-term shelter needs. The lack of utilities to areas impacted by floodwaters will prevent some of the displaced population from immediately returning to their homes. This percentage is used to help determine the short-term needs. This factor is not currently editable in Hazus.

Figure 7-18: Shelter Utility Outage Parameter Dialog



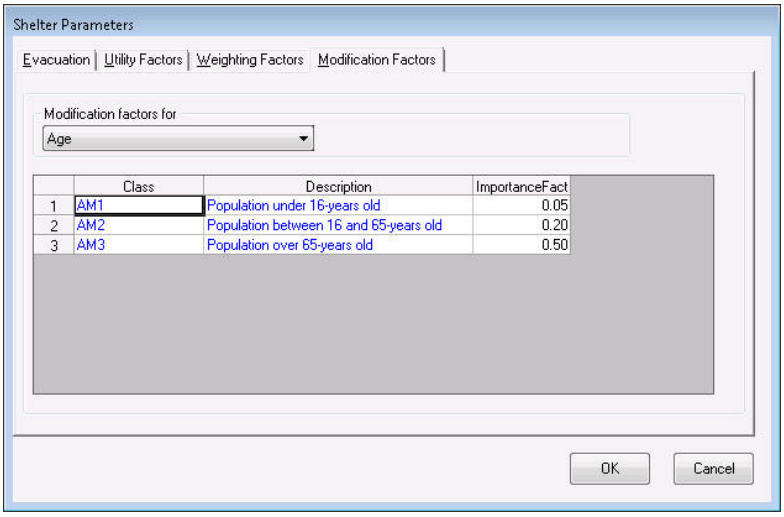
The **Weighting Factors** tab is a table where the user can modify the weighting applied to certain demographic characteristics for the population. As shown in Figure 7-19, the table includes income and age. These values should sum to 1.0.

Figure 7-19: Shelter Weighting Factors Table



The **Modification Factors** tab could be considered more closely than the weighting factors sub classification weighting. For example, Figure 7-20 shows the **Age** modification factors. These factors allow the user to place more emphasis or increase the importance of a certain population (under 16 or over 65), thereby increasing the number of people in those categories who would seek shelters. The dropdown menu also provides the user with access to the **Income** weighting. Like the **Age** factor, this weighting allows the user to place more importance on those residents that fall within a certain income range. These values should be between 0.0 and 1.0.

Figure 7-20: Shelter Modification Factors Table

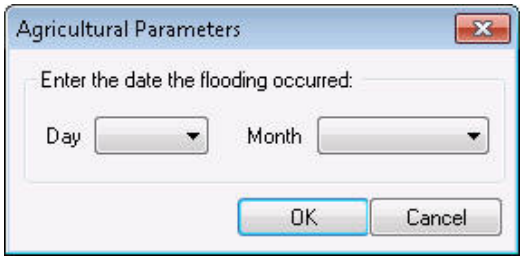


Because no default value can be provided, the **Agriculture** menu item may be most important among the analysis parameters and requires user input for the agriculture analysis to run properly. Agriculture products depend on the date when the flooding occurs. For example, if the flood occurs during the winter and the type of crops grown in the region is typically planted in

the spring, the net loss to the region will be small. However, if the flooding occurs just prior to harvest, when the farmers are the most heavily invested and their opportunity to replant is the smallest, then the impacts and losses will be greater.

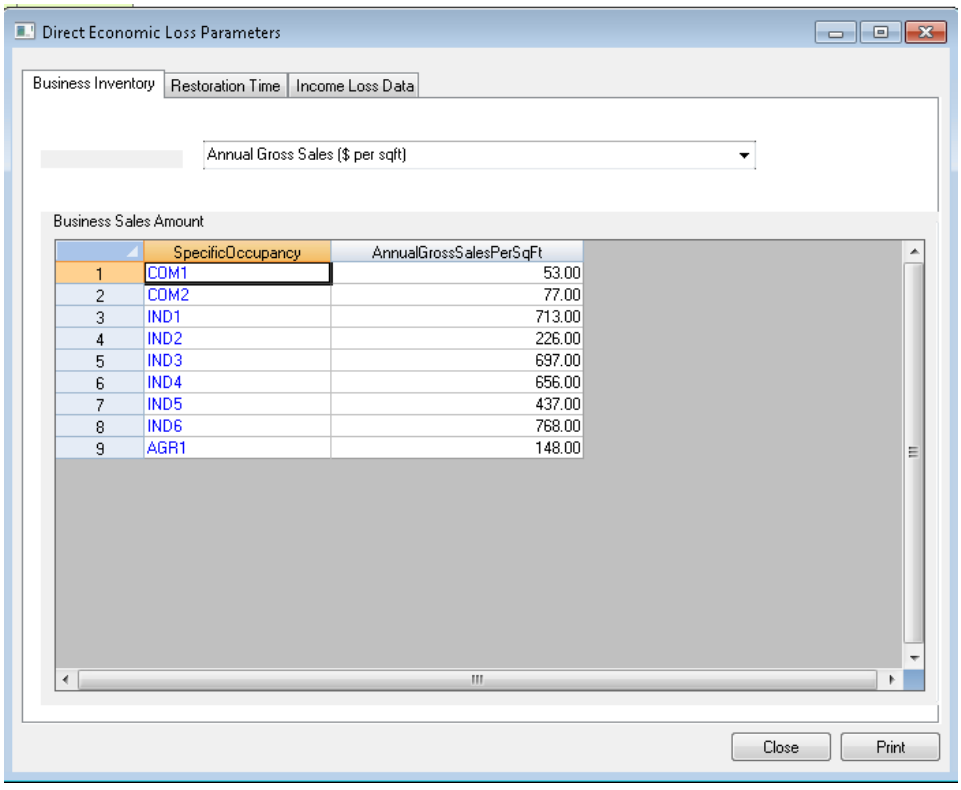
As stated previously, the Flood Model will determine the Julian date based on the date the user inputs to the Flood Model. Figure 7-21 shows the dialog in which the user provides a calendar date for when flooding occurred. Select the day (01–31) and month (January–December) from the drop-down menus for conversion to a Julian date (1–365).

Figure 7-21: Agriculture Calendar Date Parameter Dialog



The **Direct Economic** parameter menu item opens the **Direct Economic Loss Parameters** dialogs, which includes three tabs shown in Figure 7-22 through Figure 7-24. This dialog provides the user with access to the default parameters that control the estimation of the direct damages to the GBS. This includes the impact of the flood scenario on the wages, income, inventory, and maximum restoration time for the GBS. The **Business Inventory** tab defines the amount of inventory in the Study Region based on the square footage of specific census blocks.

Figure 7-22: Direct Economic Loss – Business Inventory Table



The GBS restoration functions define the maximum amount of time it should take for any given specific occupancy to be restored. For example, in Figure 7-23 the RES1 restoration time is based on the depth of flooding within the structure. In the case of RES1, even though the water has not fully entered the structure, it may take up to a year to clean up the structure, replace any sub-flooring that may be damaged, obtain permits, and perform inspections. This is a maximum timeline meant to provide a conservative estimate for the losses associated with the restoration process.

Figure 7-23: Direct Economic Loss –Restoration Time Table

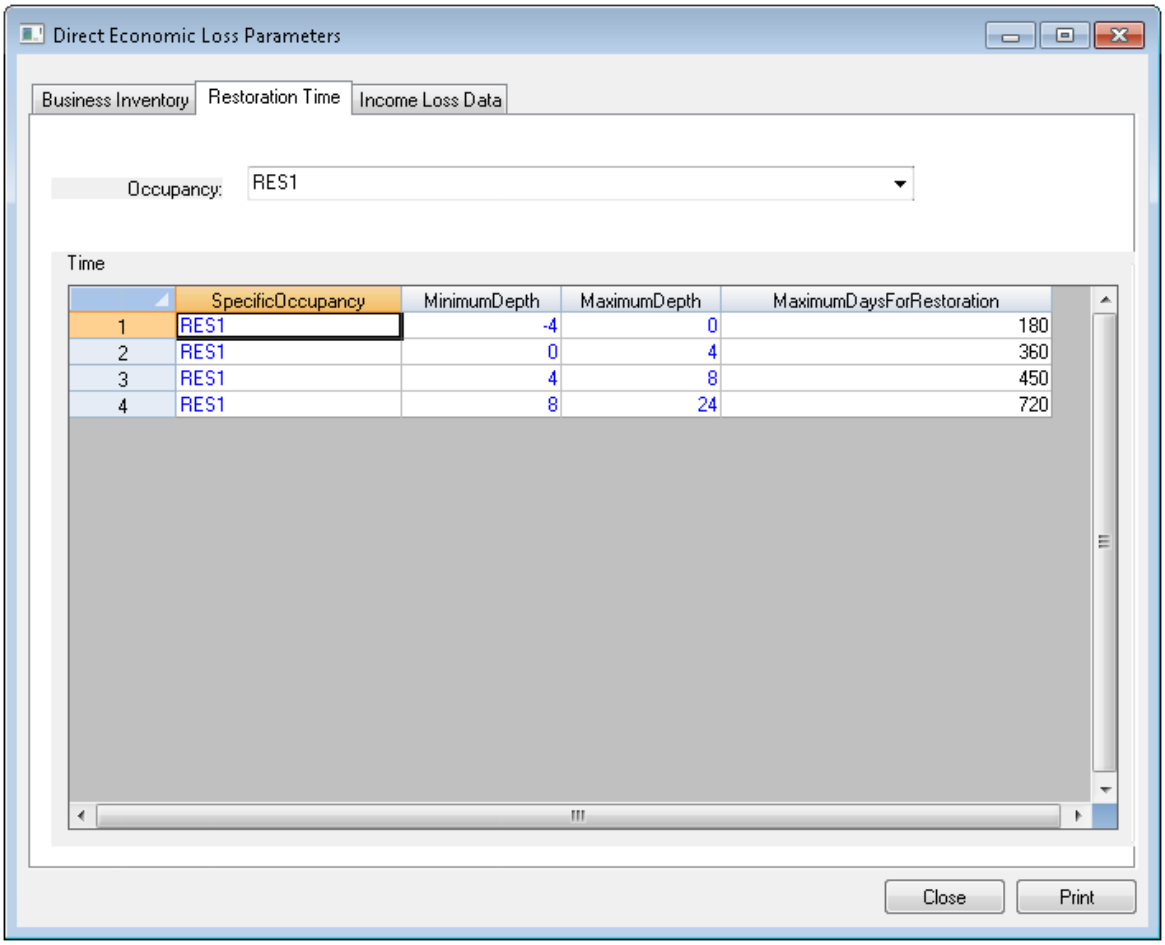
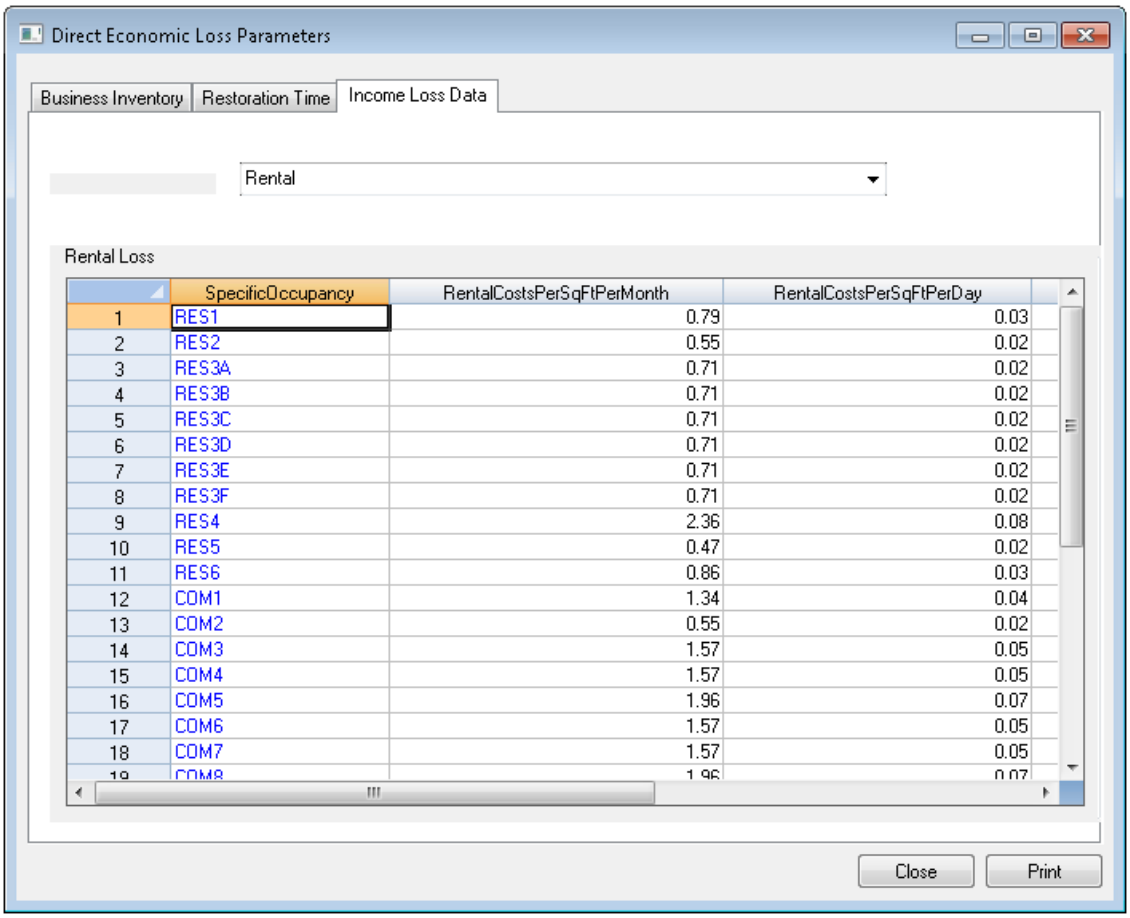


Figure 7-24 shows some additional parameters used to develop the direct losses for wages and capital income presented in the GBS economic losses.

Figure 7-24: Direct Economic Loss – Rental, Owner-Occupied, Wages and Capital, and Recapture Factors Table



	SpecificOccupancy	RentalCostsPerSqFtPerMonth	RentalCostsPerSqFtPerDay
1	RES1	0.79	0.03
2	RES2	0.55	0.02
3	RES3A	0.71	0.02
4	RES3B	0.71	0.02
5	RES3C	0.71	0.02
6	RES3D	0.71	0.02
7	RES3E	0.71	0.02
8	RES3F	0.71	0.02
9	RES4	2.36	0.08
10	RES5	0.47	0.02
11	RES6	0.86	0.03
12	COM1	1.34	0.04
13	COM2	0.55	0.02
14	COM3	1.57	0.05
15	COM4	1.57	0.05
16	COM5	1.96	0.07
17	COM6	1.57	0.05
18	COM7	1.57	0.05
19	COM8	1.96	0.07

7.4 Flood Warning

Flood warning is another key parameter (selected from the **Analysis / Flood Warning** menu shown in Figure 7-25) the user can use to perform “what-if” type analysis efforts. Flood warning is an interesting issue in that everyone assumes that damage and losses can be reduced with effective flood warning, but there is considerable disagreement over the amount of reduction, or even if it is possible to reduce damages based on effective warning. The Flood Model takes advantage of the famous Day curve developed by the USACE. This curve attempts to quantify the maximum level of damage reduction achievable based on the amount of time since the issuance of a flood warning. The curve itself approaches a maximum value of approximately 35 percent for structural, content, and business inventory losses regardless of how much warning is available.

Instead of having the user input a warning time and Hazus interpreting the Day curve to provide an expected reduction in damage, the Technical Manual provides the Day curve and the Flood Model asks the user to estimate the warning time, find the expected reduction in damage, and input this value in the dialog shown in Figure 7-26. The Flood Model will then uniformly reduce the damage by the anticipated reduction. In the case of vehicles, there is no guidance on how much vehicular damage can be avoided with warning. Conventional wisdom would indicate that the percentage should be relatively high. With little information to work from, the Flood Model allows the user to select vehicular reductions.

Figure 7-25: Analysis / Flood Warning Menu

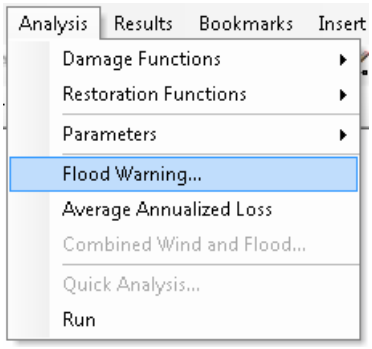
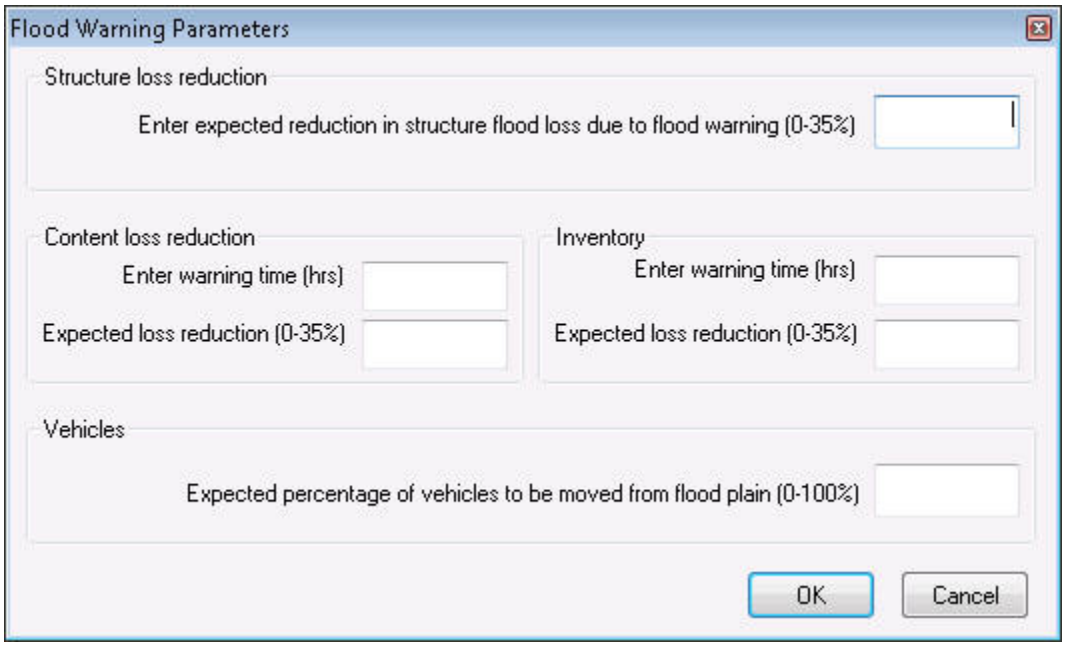


Figure 7-26: Warning Parameters Dialog



Note that the parameters for structures, contents, and business inventory are limited to a maximum of 35 percent based on the maximum provided by the Day curves. The user could input 100 percent reduction for vehicular damage, and this may not be unreasonable if an area is evacuated with plenty of warning time. Note that the Flood Model provides the user the option to input the warning time to help them remember the parameters that led to the value input into the dialog.

7.5 Annualized Loss

Average Annualized Loss Menu, shown in Figure 7-27, is the calculation step where a user combines a series of individual recurrence interval losses into an additional estimate for annual loss. This analysis is performed after the user has performed a **Full Suite of Return Periods** analysis in the **Hazard** menu (as shown in Figure 7-28 and Figure 7-29 for riverine and coastal analysis) and has performed a loss analysis in the **Analysis / Run** menu.

Figure 7-27: Analysis / Average Annualized Loss Menu

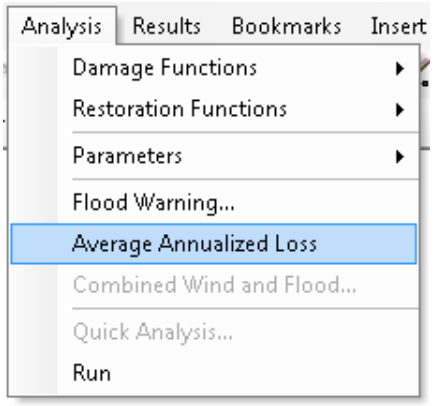


Figure 7-28: Riverine Flood Full Suite of Return Periods Analysis

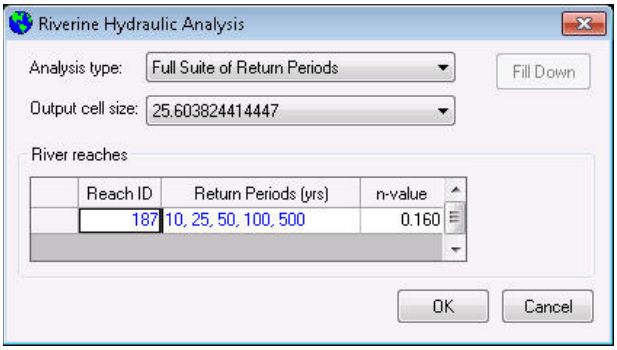
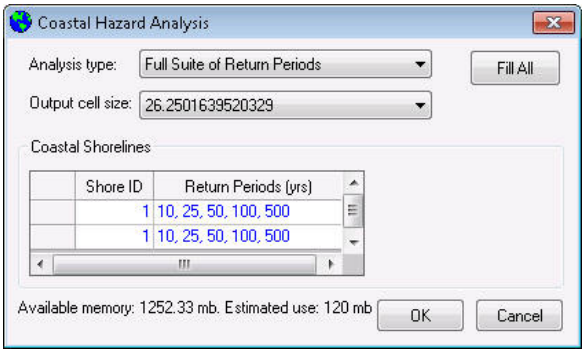
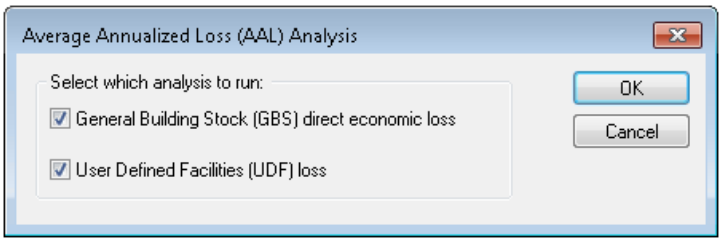


Figure 7-29: Coastal Flood Full Suite of Return Periods Analysis



The user has the option of performing average annualized loss calculations for either GBS or UDF data, as shown in the **Average Annualized Loss Analysis** dialog (Figure 7-30) if loss analysis has been performed for the five required events (10-, -25-, 50-, 100-, and 500-year).

Figure 7-30: Average Annualized Loss Analysis Dialog



If the user has not performed the required loss analysis prior to trying to run the average annualized loss (AAL), Hazus will produce the error messages shown in Figure 7-31 and Figure 7-32 requesting the user to perform these prerequisite analyses.

Figure 7-31: Average Annualized Loss GBS Error Dialog

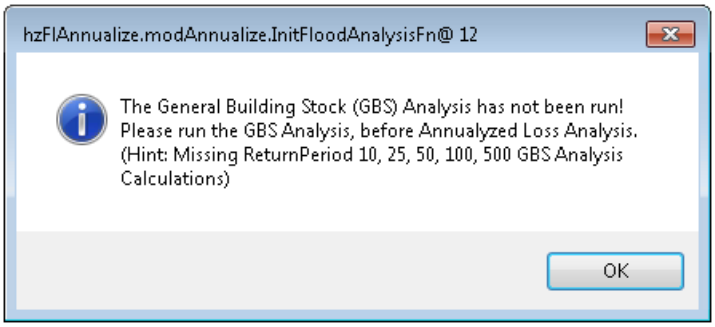
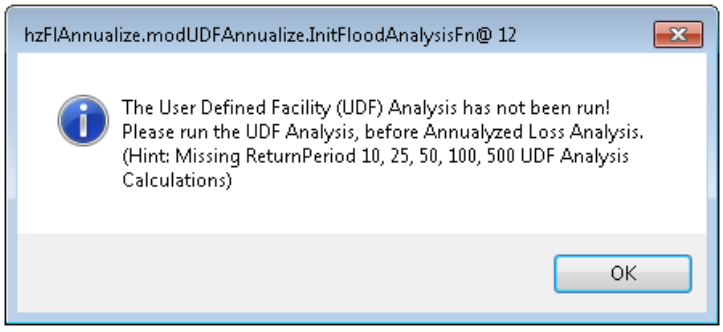


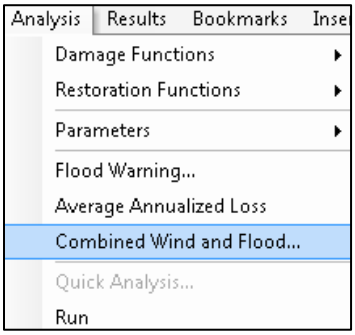
Figure 7-32: Average Annualized Loss UDF Error Dialog



7.6 Combined Wind and Flood

The **Combined Wind and Flood** menu (Figure 7-33) will become activated when a user has performed the prerequisite analysis for a storm surge analysis in both the Hurricane Model and Flood Model. See Chapter 11 for more details on all of the steps to perform this type of analysis.

Figure 7-33: Analysis / Combined Wind and Flood Menu



7.7 Quick Analysis: Quick Look and Enhanced Quick Look

Chapter 13 includes detailed step-by-step instructions on how to perform **Quick Look** and **Enhanced Quick Look** analyses.

The **Quick Look** and **Enhanced Quick Look** were created to provide the user a way of performing a very quick “snapshot” type analysis to gain some insight into a particular problem. The **Quick Analysis** is intended to be used on very localized flooding issues, and is intended to allow the user to establish some known condition and attempt to provide a quick quantification of potential loss. **Quick Look** and **Enhanced Quick Look** do not establish a flow regime.

The following is an example of how the **Quick Analysis** might be used:

Heavy rains fall in a community with one basin where water typically collects. Several years later, the area, which is outside of any regulatory floodplain, has been developed. In **Quick Look**, the user can quickly draw a few polygons and assign a depth of flooding to each in accordance with the recollections of the local population. In **Enhanced Quick Look**, the user can import a floodplain boundary polygon along with the DEM. The user would then perform a loss analysis to identify potential losses.

7.8 Run

Once the user parameters have been selected or modified, select **Run** from the **Analysis** menu (Figure 7-34). The Analysis Options dialog shown in Figure 7-35 will appear. Clicking on the plus and minus signs will expand and collapse the lists of available options, respectively. Click on the boxes of the desired analysis options. A check mark will appear to indicate the options have been selected. Note that some analysis options have pre-requisite analysis requirements and selection of those options will automatically check the box of the prerequisites. At the bottom of the dialog, Hazus will indicate the amount of hard drive disk space available on the machine and the percentage of the Study Region’s database that has been used thus far. The

Study Region's database has a limit of 10 GB; therefore, if the percentage used is more than 50 percent, less than 5 GB of space is available for the analysis.

Figure 7-34: Analysis / Run Menu

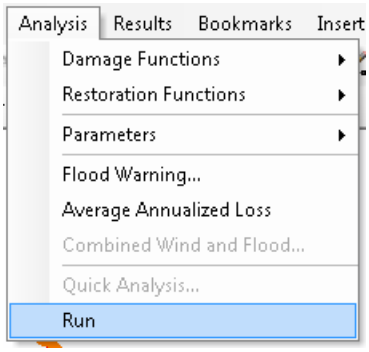
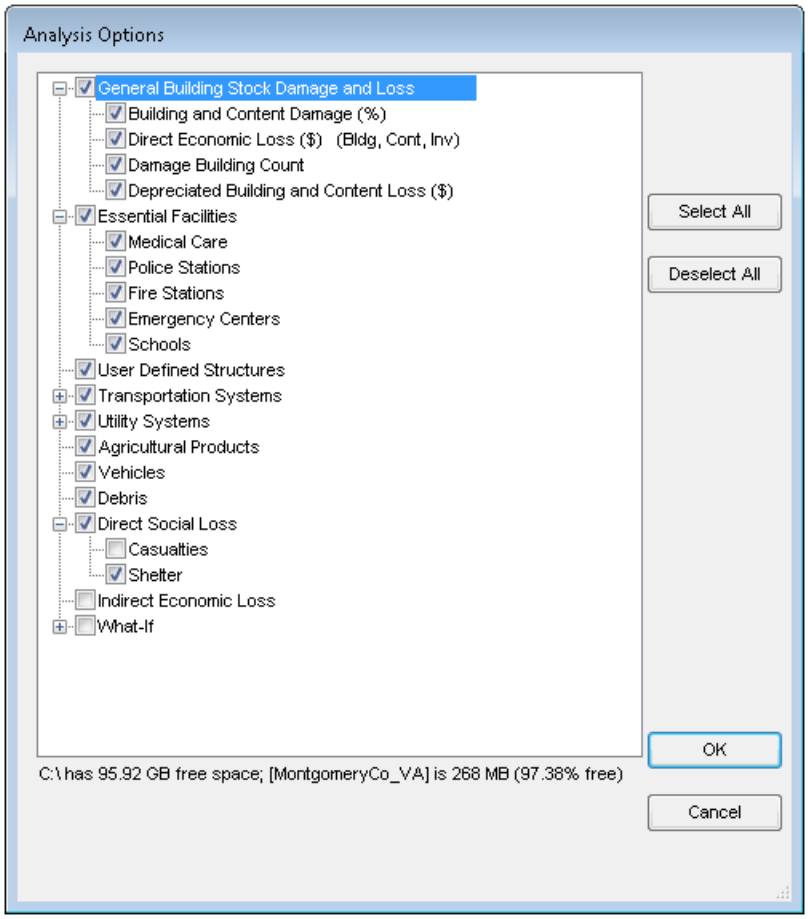


Figure 7-35: Select Analysis Options



Hazus can conduct default analysis runs for the following items:

- GBS
- Essential facilities
- Selected infrastructure, including highway bridges and water systems
- Agriculture products
- Vehicles
- Debris
- Shelter requirements

The types of default data provided for the Study Region limit the type of analysis that can be run. To run a What-If analysis, the same analysis must have been run from the hazard menu. When the desired analysis options have been selected, click **OK**.

- When running the Analysis, the **Hazus** screen might go blank or the Task Manager **Applications** tab will indicate that **Hazus** is not responding. This is a common occurrence for any software process-heavy software. To see whether **Hazus** is still running, check the Task Manager **Processes** tab and sort the **CPU** column in descending order. The "sqlservr.exe" process should be on top. If the "System Idle Process" is constantly on top at 99–100%, **Hazus** is not responding. Also, check the **Performances** tab and make sure the CPU Usage is not 0 over a period of time. Another option is to open the scenario folder (in "Details" view within Windows Explorer) and make sure the FlAnalysisLog is updating by looking at the "Date modified."
- Running the Analysis, specifically the General Building Stock Damage and Loss, can take up to many hours to process and successfully complete.

For users who would like to view the intermediate analysis completion status, go to **Customize** menu and select **Flood Options** (as shown in Figure 7-36), and check the **Show redo analyses Warning message box(es)** checkbox (example shown in Figure 7-37). This option only applies if the user is redoing the analyses.

Figure 7-36: Customize / Flood Options Menu

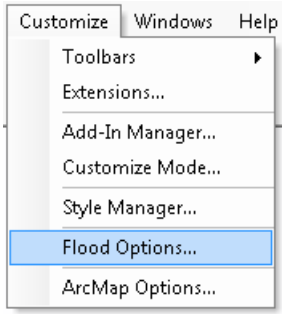
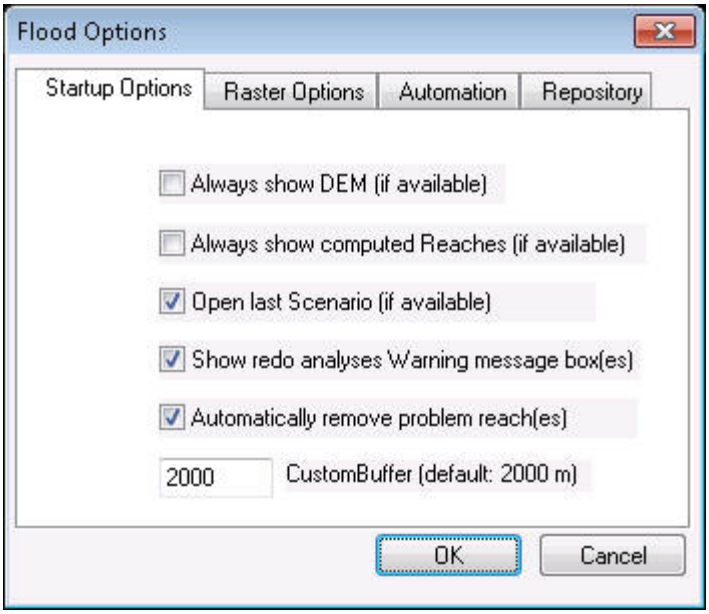


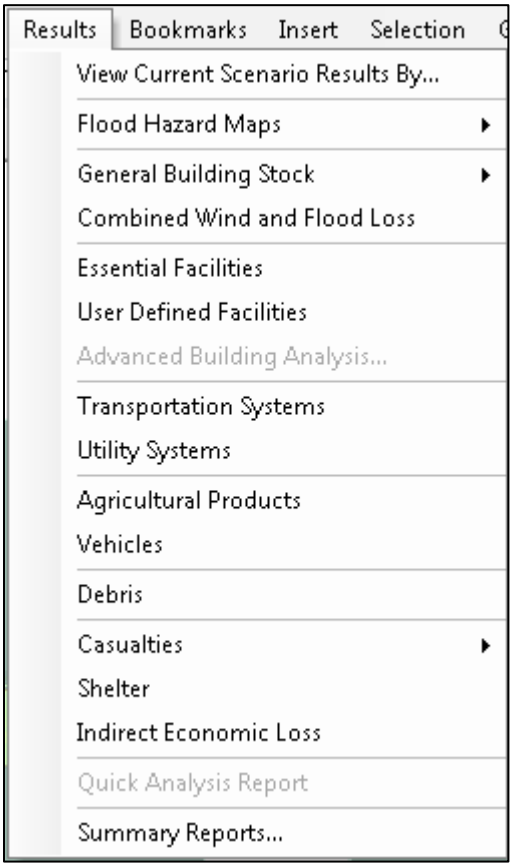
Figure 7-37: Check Show Redo Analyses Warning Message Box(es)



8 Model Menu: Results

The **Results** menu (Figure 8-1) within Hazus has a number of analysis types and menus from which to choose. These options enable the user to select the appropriate results to review in the Study Region. This section explains each selection and menu to further the user's understanding of these options. The analyses associated with **Advanced Building Analysis** and **Indirect Economic Analysis** is inactive in the Flood Model.

Figure 8-1: Results Menu



8.1 View Current Scenario Results By

Once the loss analysis has been run, the next step is to view the results. The first option within the **Results** menu (Figure 8-2) is **View Current Scenario Results By…**. Selecting this option activates the **View Results by** window shown in Figure 8-3. Select one of the **Available Results**. No results can be viewed until a hazard analysis has been selected.

Figure 8-2: Results / View Current Scenario Results By Menu

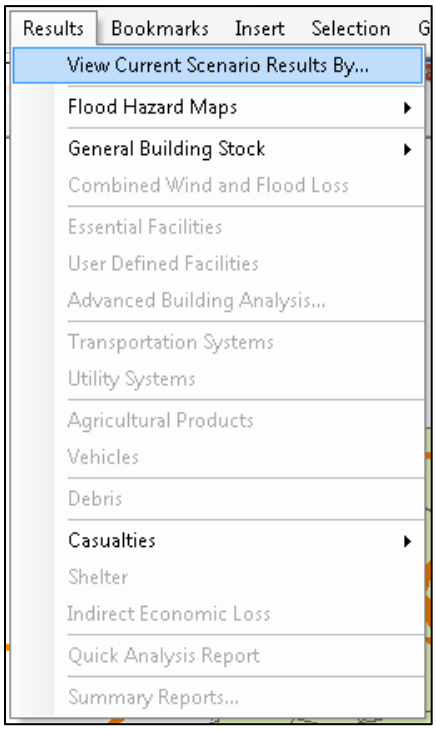
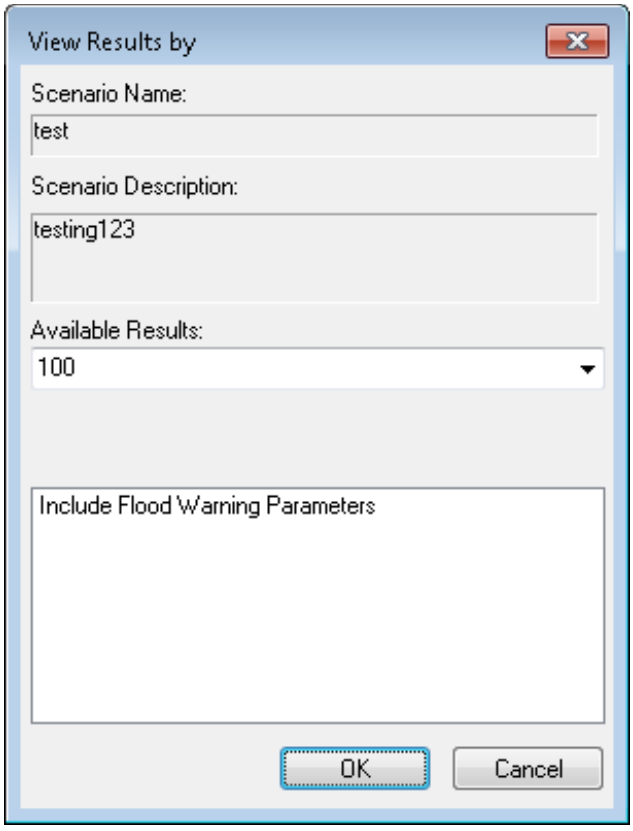


Figure 8-3: Select Available Results



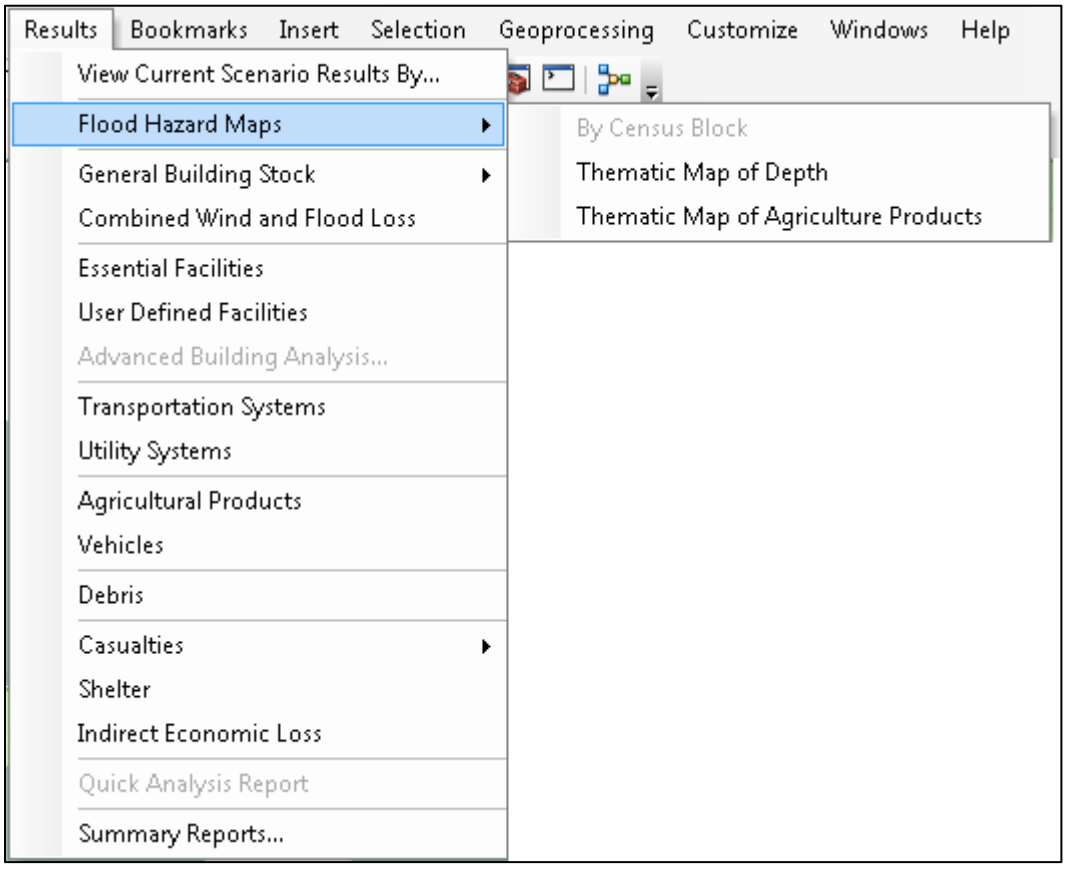
8.2 Flood Hazard Map

To map the flood depth grid and floodplain boundary for the current scenario and return period/discharge(s), select **Thematic Map of Depth** from the **Results / Flood Hazard Maps** menu. The flood depth grid will be displayed in blue. The floodplain boundary will be displayed in orange in the main Flood Model map window.

The three options on the **Results / Flood Hazard Maps** menu (Figure 8-4), **By Census Block**, **Thematic Map of Depth**, and **Thematic Map of Agriculture Products**, will add specific symbolized layers to the map. These options can be used as visualization tools to understand specific spatial patterns in the Study Region.

Hazus automatically maps the flood depth grid and floodplain boundary for one of the available depth grids when the hazard is computed, but other flood depth grids are available to be mapped that may have also been computed.

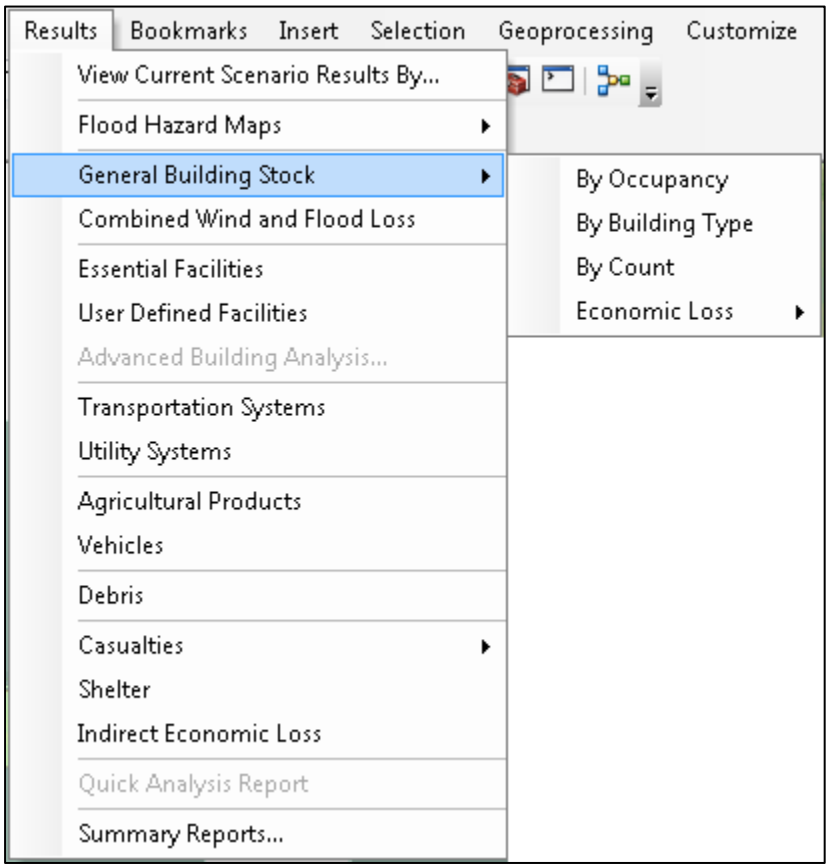
Figure 8-4: Results / Flood Hazard Maps Menu



8.3 General Building Stock Damage

To view and map the general inventory damage results By Occupancy, By Building Type, and By Count, select **General Building Stock** from the **Results** menu (Figure 8-5).

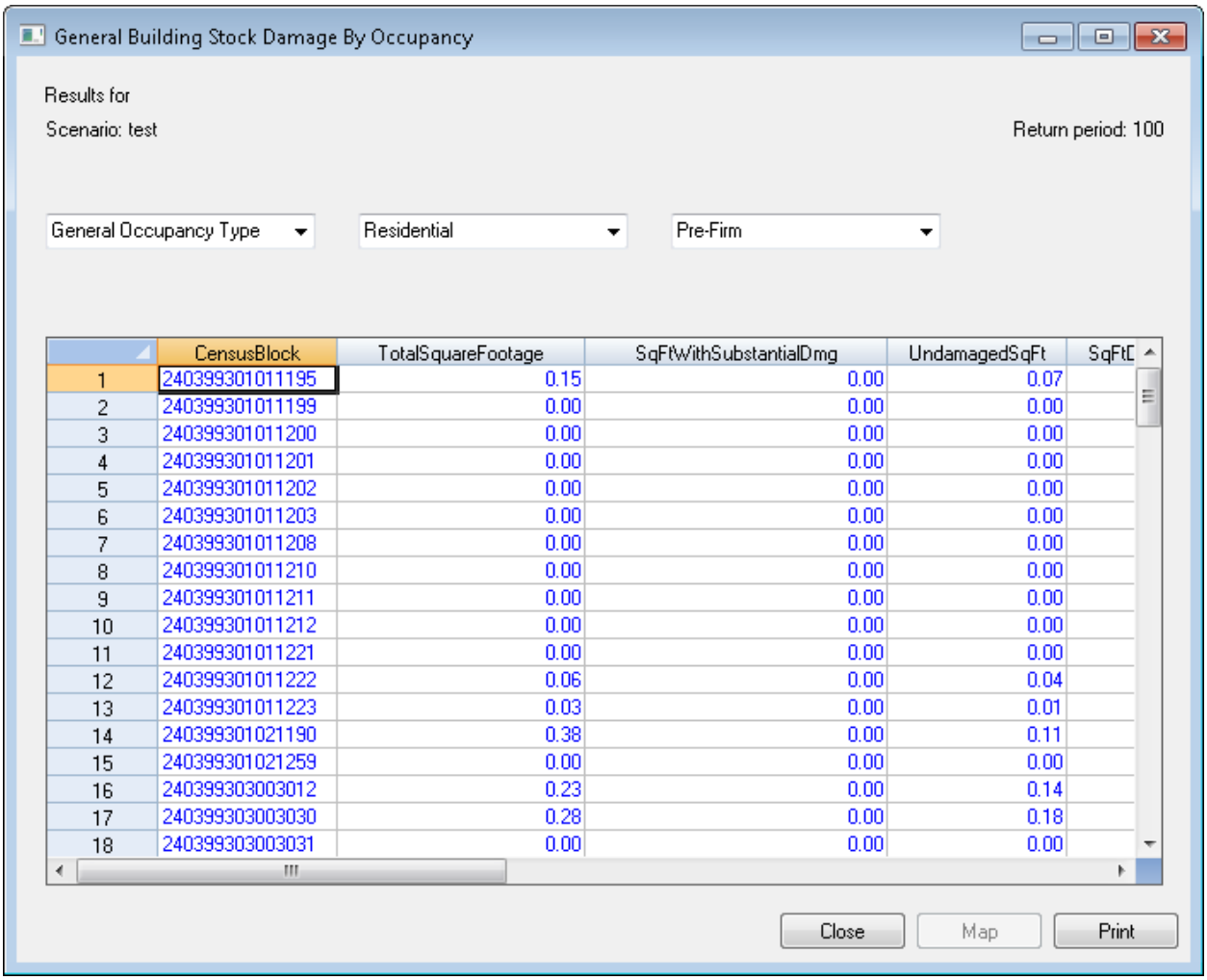
Figure 8-5: Results / General Building Stock Menu



8.3.1 General Building Stock Damage by Occupancy

Select **By Occupancy** from the **Results** / **General Building Stock** menu (Figure 8-5) to view and map tabular damage results by census block. The user can show values based on **General Occupancy Type** or **Specific Occupancy Type** and choose between **Pre-Firm**, **Post-Firm**, or **All** (Figure 8-6). Select a specific column with numeric values in the table and click the **Map** button to map the tabular results. Mapped results will appear on the screen.

Figure 8-6: General Building Stock Damage Results Table

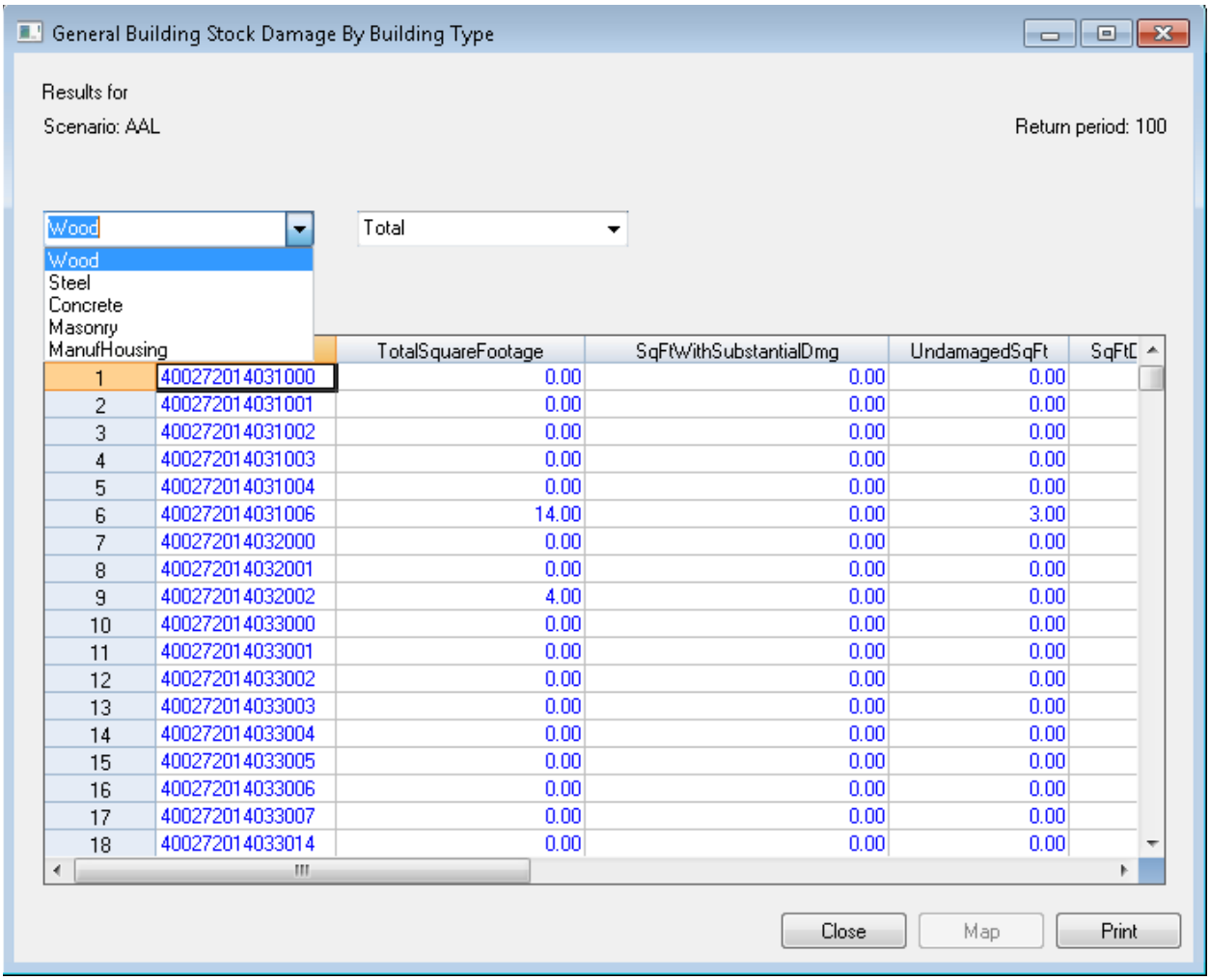


	CensusBlock	TotalSquareFootage	SqFtWithSubstantialDmg	UndamagedSqFt	SqFtD
1	240399301011195	0.15	0.00	0.07	
2	240399301011199	0.00	0.00	0.00	
3	240399301011200	0.00	0.00	0.00	
4	240399301011201	0.00	0.00	0.00	
5	240399301011202	0.00	0.00	0.00	
6	240399301011203	0.00	0.00	0.00	
7	240399301011208	0.00	0.00	0.00	
8	240399301011210	0.00	0.00	0.00	
9	240399301011211	0.00	0.00	0.00	
10	240399301011212	0.00	0.00	0.00	
11	240399301011221	0.00	0.00	0.00	
12	240399301011222	0.06	0.00	0.04	
13	240399301011223	0.03	0.00	0.01	
14	240399301021190	0.38	0.00	0.11	
15	240399301021259	0.00	0.00	0.00	
16	240399303003012	0.23	0.00	0.14	
17	240399303003030	0.28	0.00	0.18	
18	240399303003031	0.00	0.00	0.00	

8.3.2 General Building Stock Damage by Building Type

Select **By Type** from the Results / **General Building Stock** menu (Figure 8-5) to view and map tabular damage results for wood, steel, concrete, masonry, and manufactured housing types. Select the desired type of structure from the dropdown menu (Figure 8-7).

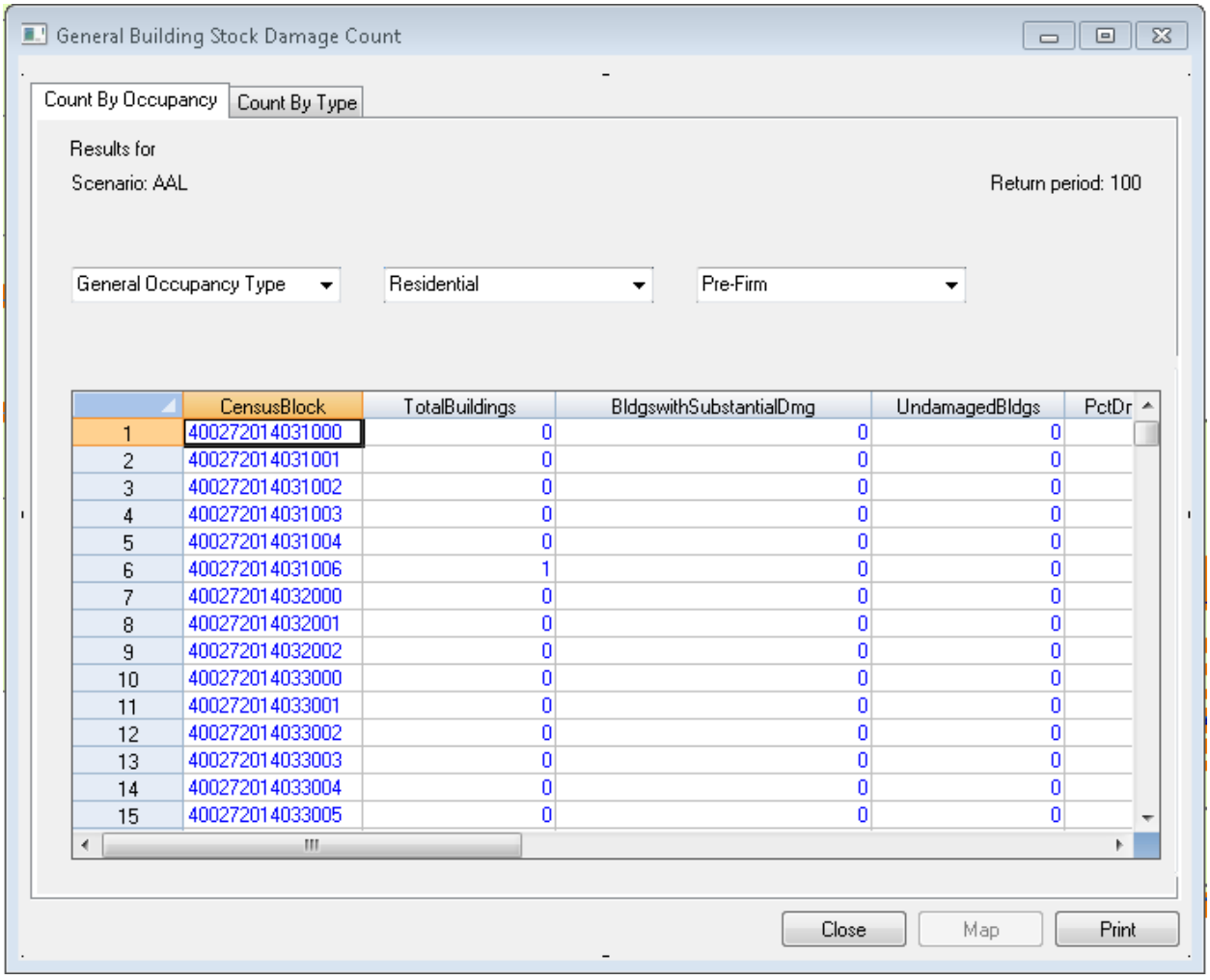
Figure 8-7: Building Stock Damage by Building Type Table



8.3.3 General Building Stock Damage Count

Select **By Count** from the **Results / General Building Stock** menu (Figure 8-5) to view and map the tabular damage results. For **County By Occupancy**, the user can choose counts based on **General Occupancy Type** or **Specific Occupancy Type** and choose between **Pre-Firm**, **Post-Firm**, or **All** (Figure 8-8). Use the dropdown menus to select which data to view.

Figure 8-8: General Building Stock Damage Count Table

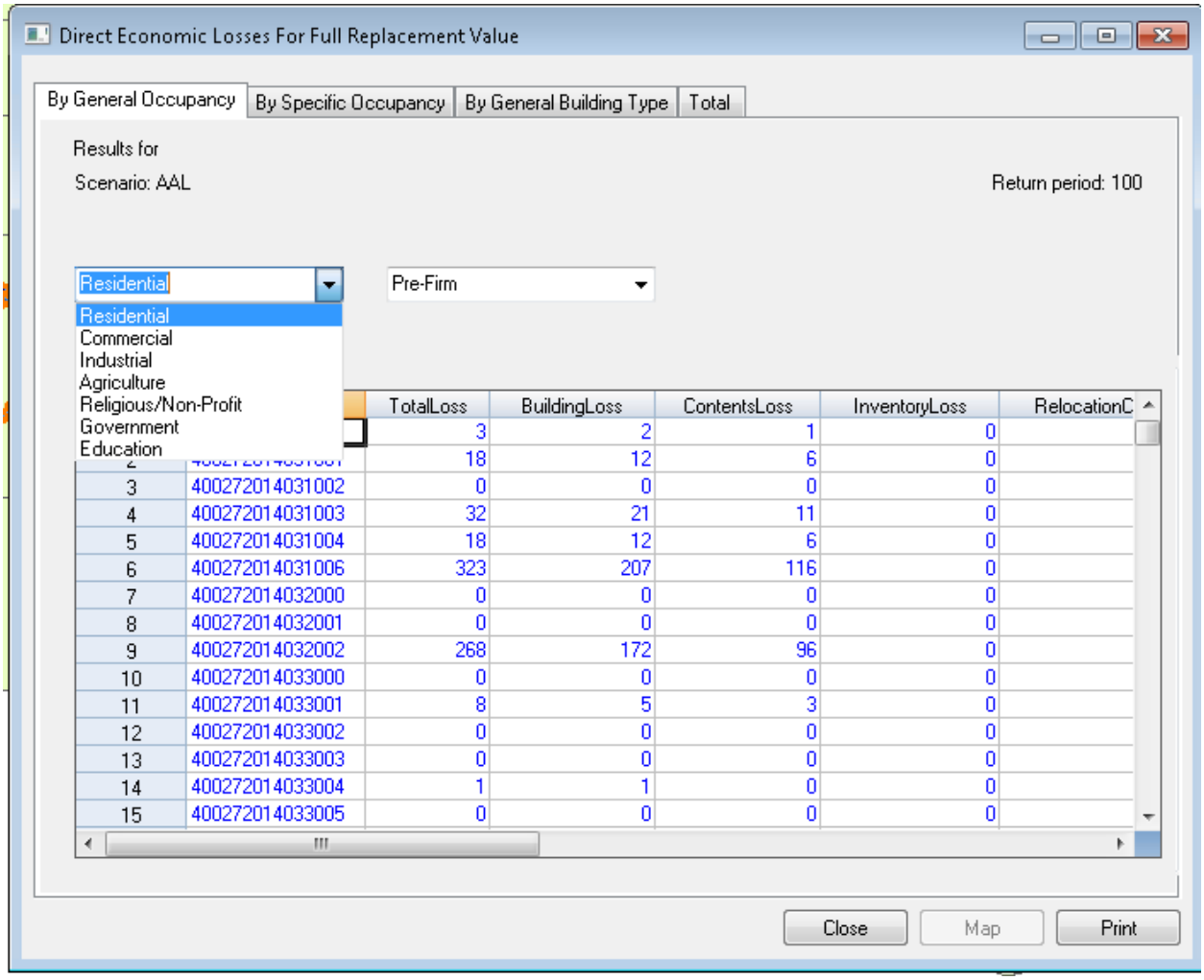


	CensusBlock	TotalBuildings	BldgswithSubstantialDmg	UndamagedBldgs	PctDr
1	400272014031000	0	0	0	
2	400272014031001	0	0	0	
3	400272014031002	0	0	0	
4	400272014031003	0	0	0	
5	400272014031004	0	0	0	
6	400272014031006	1	0	0	
7	400272014032000	0	0	0	
8	400272014032001	0	0	0	
9	400272014032002	0	0	0	
10	400272014033000	0	0	0	
11	400272014033001	0	0	0	
12	400272014033002	0	0	0	
13	400272014033003	0	0	0	
14	400272014033004	0	0	0	
15	400272014033005	0	0	0	

8.3.4 General Building Stock Direct Economic Losses

The **Economic Loss** option on the **Results / General Building Stock** menu allows the user to view and map economic losses for the GBS by census block by full replacement value and depreciated replacement value. Direct economic losses can be displayed **By General Occupancy**, **By Specific Occupancy**, **By General Building Type**, and **Total** as shown in Figure 8-9. Use the dropdown menus to select which data to view.

Figure 8-9: General Building Stock Direct Economic Losses for Full Replacement Value (By General Occupancy) Table

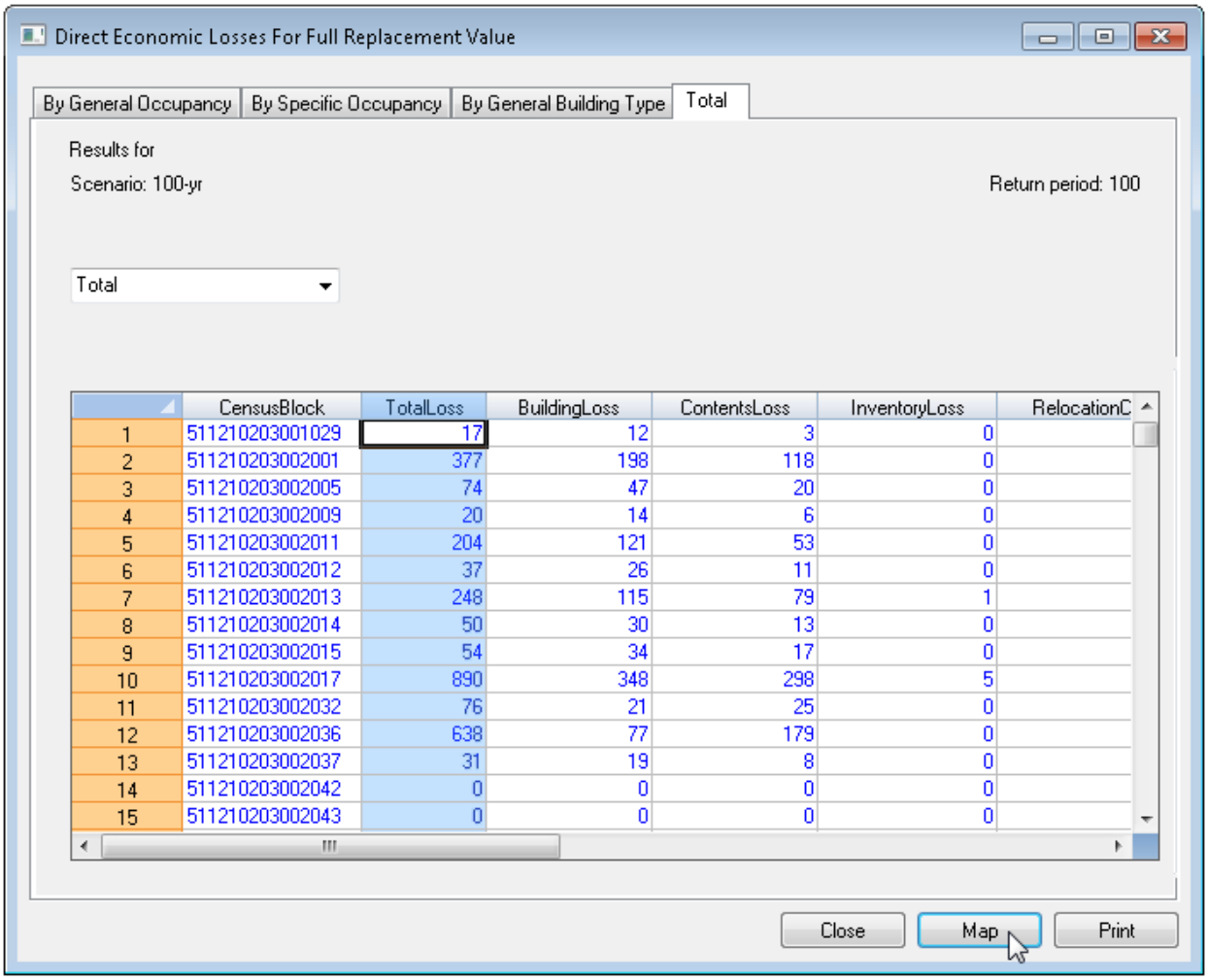


8.3.5 Viewing and Exporting Data from Building Stock Damage Menus

To view the damage results spatially, click on one of the columns with loss values, such as the **TotalLoss** field (Figure 8-10) on the desired tab of the Direct Economic Losses table and click the **Map** button at the bottom right hand corner. The data will appear a new data layer within the Hazus project and ESRI shapefile format. Once the data are listed in the Flood Map Table of Contents, right click on the data layer and export the data to a shapefile, which can be imported into database and spreadsheet programs for further analysis.

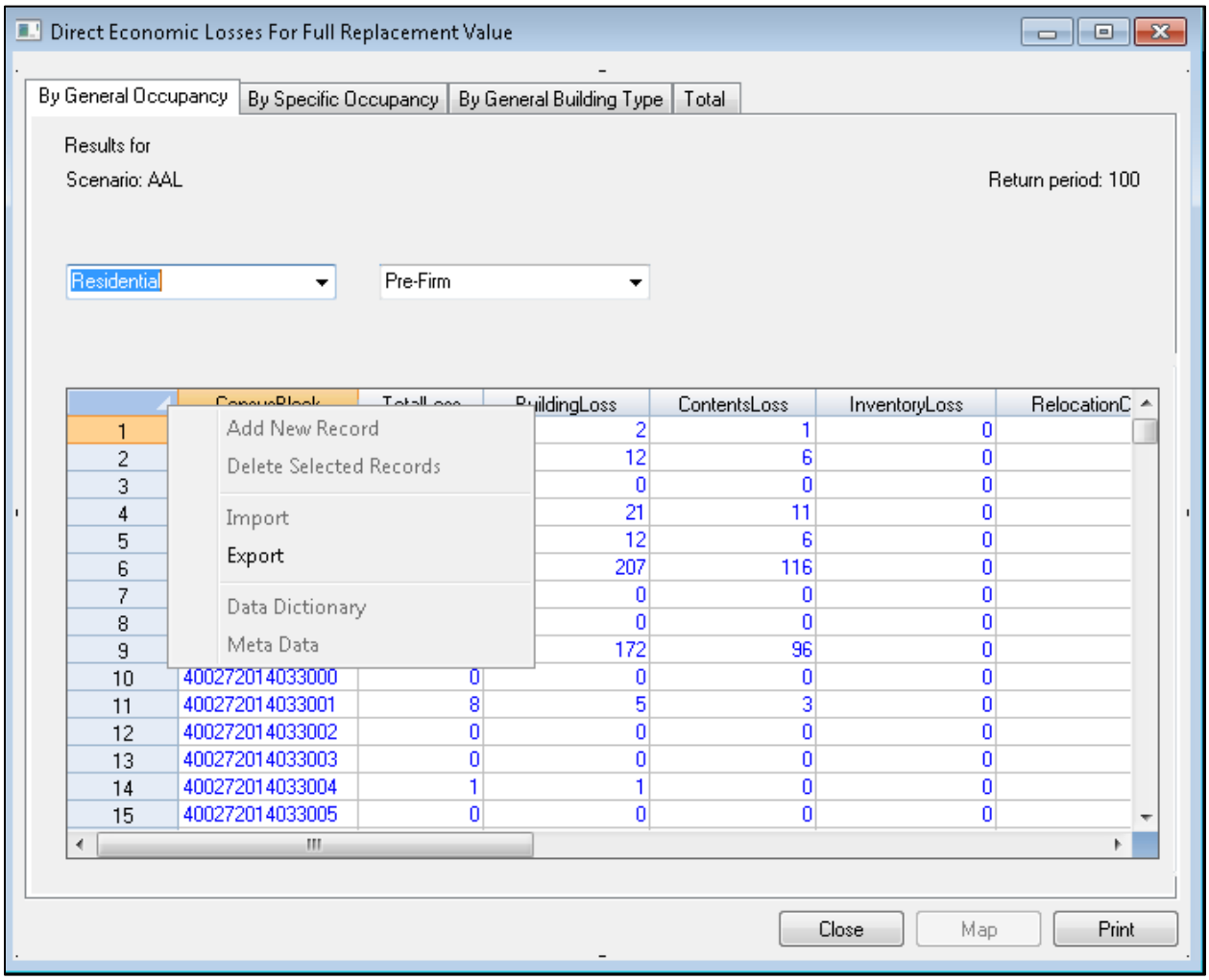
To view the damage results only in a tabular format, right click within the table and select **Export** (Figure 8-11).

Figure 8-10: General Building Stock Direct Economic Losses for Full Replacement Value (Total) Results



	CensusBlock	TotalLoss	BuildingLoss	ContentsLoss	InventoryLoss	RelocationC
1	511210203001029	17	12	3	0	
2	511210203002001	377	198	118	0	
3	511210203002005	74	47	20	0	
4	511210203002009	20	14	6	0	
5	511210203002011	204	121	53	0	
6	511210203002012	37	26	11	0	
7	511210203002013	248	115	79	1	
8	511210203002014	50	30	13	0	
9	511210203002015	54	34	17	0	
10	511210203002017	890	348	298	5	
11	511210203002032	76	21	25	0	
12	511210203002036	638	77	179	0	
13	511210203002037	31	19	8	0	
14	511210203002042	0	0	0	0	
15	511210203002043	0	0	0	0	

Figure 8-11: Export General Building Stock Direct Economic Losses for Full Replacement Value (By Occupancy) Results



8.4 Combined Wind and Flood Loss

When a storm surge analysis has been performed (see Chapter 11 for all steps in that type of analysis), the user can show results from the combined wind flood loss analysis with the **Combined Wind and Flood Loss** menu (Figure 8-12). Selecting that menu will bring up the window shown in Figure 8-13, which includes some of the fields that Hazus calculated when a combined hurricane wind and flood surge analysis was conducted, where results are shown for each hazard type individually and the weighted combination. The combined losses are weighted based on how each hazard type contributes to overall damages, with flood hazards typically damaging the lower portions of a structure (foundation, lower floors) and hurricane wind hazards typically damaging upper portions of a structure (roof, upper floors). Refer to the Hazus Flood and Hurricane Technical Manuals for more details on how the combined results are calculated.

Figure 8-12: Results / Combined Wind and Flood Loss Menu

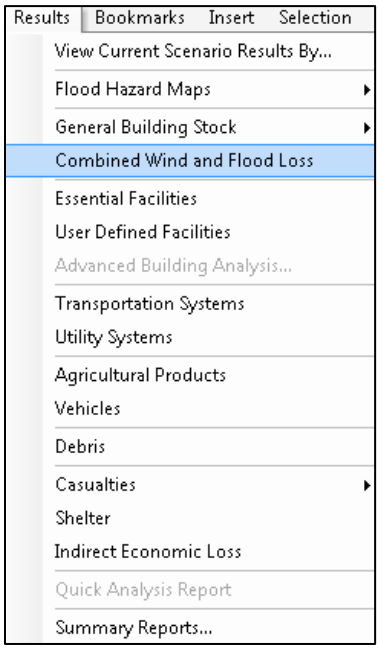
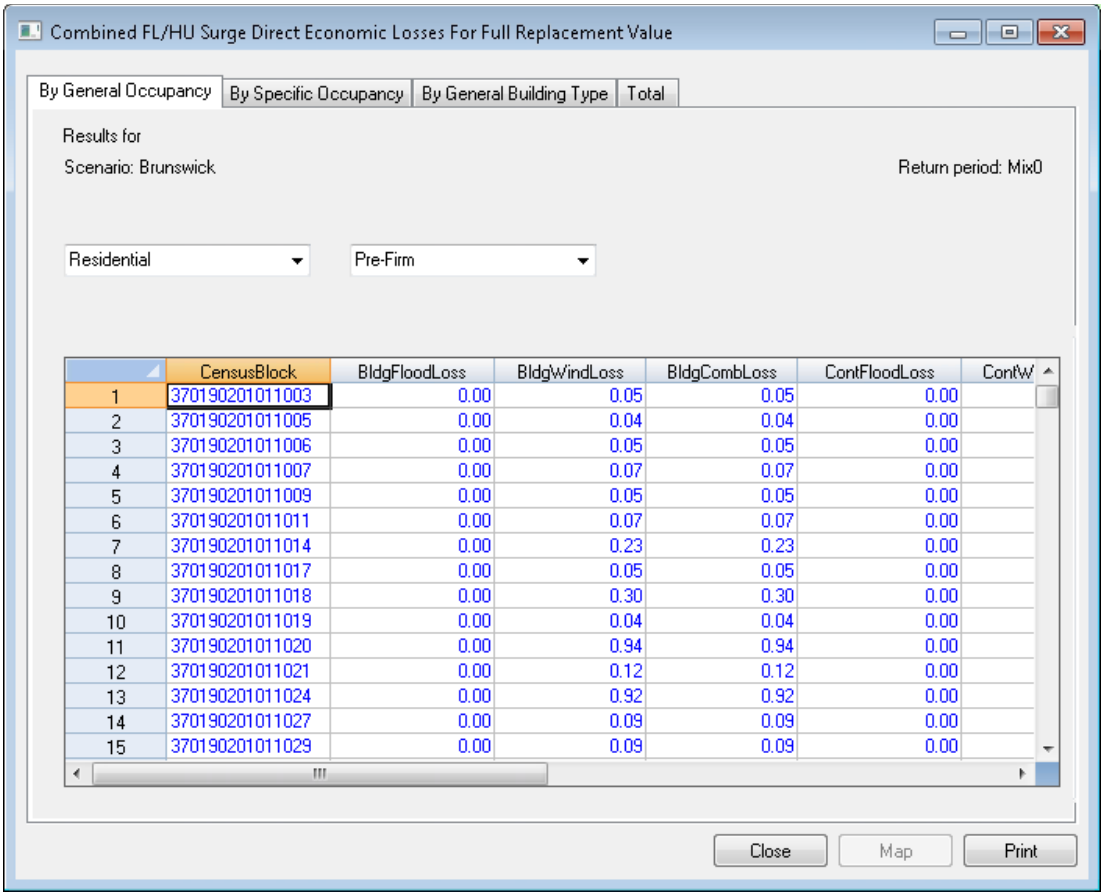


Figure 8-13: Combined FL/HU Surge Direct Economic Losses for Full Replacement Value (By General Occupancy) Table



	CensusBlock	BldgFloodLoss	BldgWindLoss	BldgCombLoss	ContFloodLoss	ContW
1	370190201011003	0.00	0.05	0.05	0.00	
2	370190201011005	0.00	0.04	0.04	0.00	
3	370190201011006	0.00	0.05	0.05	0.00	
4	370190201011007	0.00	0.07	0.07	0.00	
5	370190201011009	0.00	0.05	0.05	0.00	
6	370190201011011	0.00	0.07	0.07	0.00	
7	370190201011014	0.00	0.23	0.23	0.00	
8	370190201011017	0.00	0.05	0.05	0.00	
9	370190201011018	0.00	0.30	0.30	0.00	
10	370190201011019	0.00	0.04	0.04	0.00	
11	370190201011020	0.00	0.94	0.94	0.00	
12	370190201011021	0.00	0.12	0.12	0.00	
13	370190201011024	0.00	0.92	0.92	0.00	
14	370190201011027	0.00	0.09	0.09	0.00	
15	370190201011029	0.00	0.09	0.09	0.00	

8.5 Essential Facilities

Essential Facilities results, selected in Figure 8-14 and shown in Figure 8-15, allow the user to view and map losses and damages to Essential Facilities, including **Medical Care Facilities**, **Emergency Centers**, and **Schools**. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Figure 8-14: Results / Essential Facilities Menu

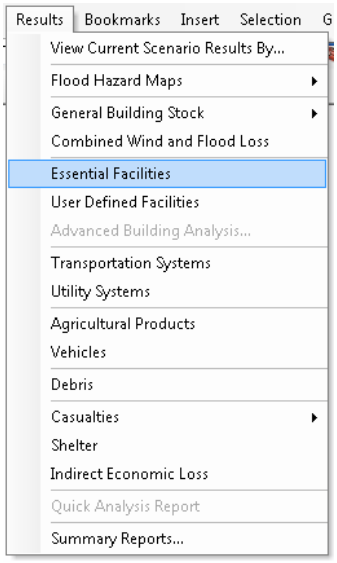
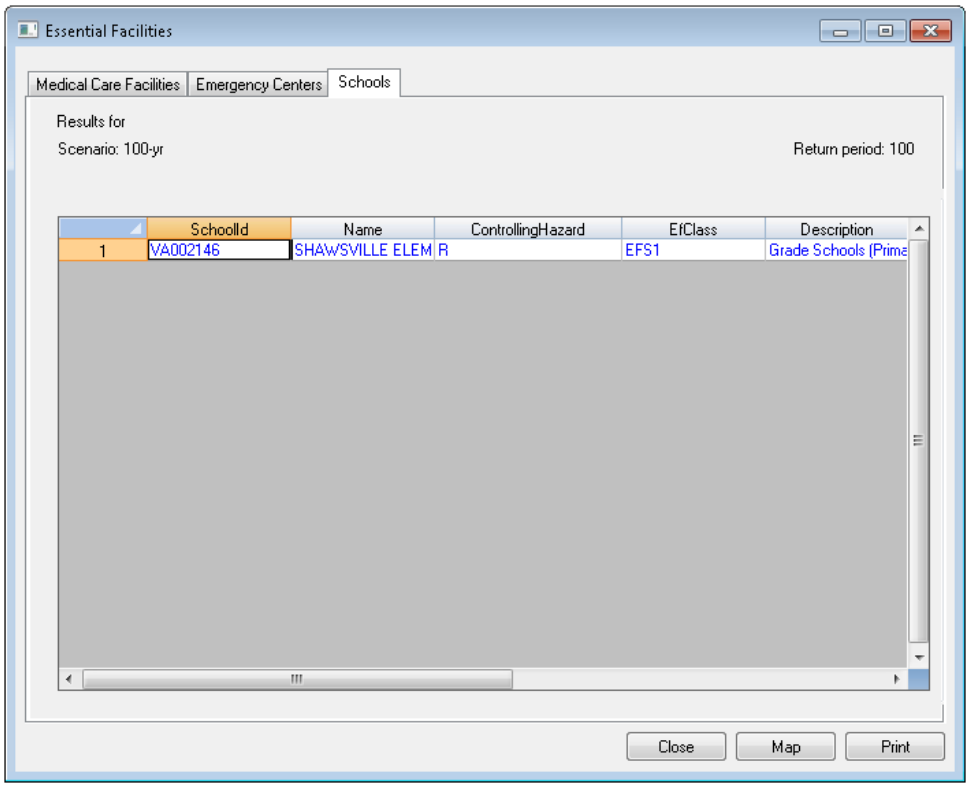


Figure 8-15: Essential Facilities (Schools) Table



8.6 User-Defined Facilities

User-Defined Facilities results, selected in Figure 8-16 and shown in Figure 8-17, allow the user to view and map losses and damages to individual UDFs. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Figure 8-16: Results / User-Defined Facilities Menu

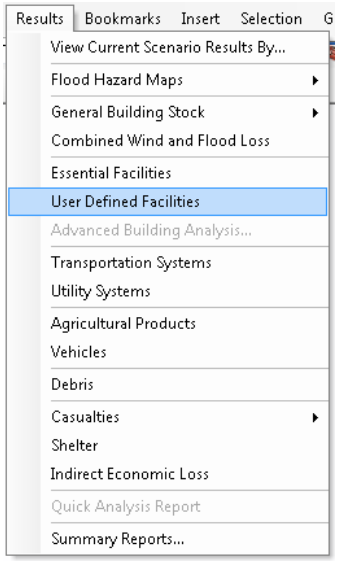
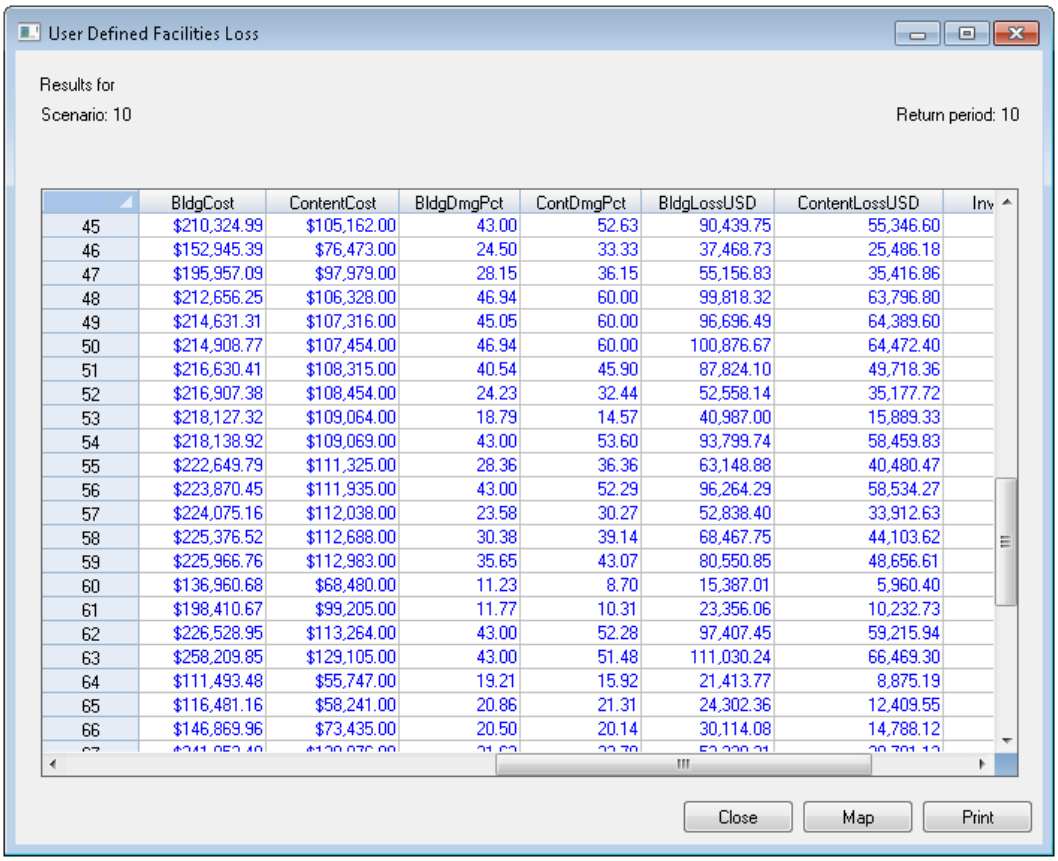


Figure 8-17: User-Defined Facilities Loss Table



	BldgCost	ContentCost	BldgDmgPct	ContDmgPct	BldgLossUSD	ContentLossUSD	Inv
45	$210,324.99	$105,162.00	43.00	52.63	90,439.75	55,346.60	
46	$152,945.39	$76,473.00	24.50	33.33	37,468.73	25,486.18	
47	$195,957.09	$97,979.00	28.15	36.15	55,156.83	35,416.86	
48	$212,656.25	$106,328.00	46.94	60.00	99,818.32	63,796.80	
49	$214,631.31	$107,316.00	45.05	60.00	96,696.49	64,389.60	
50	$214,908.77	$107,454.00	46.94	60.00	100,876.67	64,472.40	
51	$216,630.41	$108,315.00	40.54	45.90	87,824.10	49,718.36	
52	$216,907.38	$108,454.00	24.23	32.44	52,558.14	35,177.72	
53	$218,127.32	$109,064.00	18.79	14.57	40,987.00	15,889.33	
54	$218,138.92	$109,069.00	43.00	53.60	93,799.74	58,459.83	
55	$222,649.79	$111,325.00	28.36	36.36	63,148.88	40,480.47	
56	$223,870.45	$111,935.00	43.00	52.29	96,264.29	58,534.27	
57	$224,075.16	$112,038.00	23.58	30.27	52,838.40	33,912.63	
58	$225,376.52	$112,688.00	30.38	39.14	68,467.75	44,103.62	
59	$225,966.76	$112,983.00	35.65	43.07	80,550.85	48,656.61	
60	$136,960.68	$68,480.00	11.23	8.70	15,387.01	5,960.40	
61	$198,410.67	$99,205.00	11.77	10.31	23,356.06	10,232.73	
62	$226,528.95	$113,264.00	43.00	52.28	97,407.45	59,215.94	
63	$258,209.85	$129,105.00	43.00	51.48	111,030.24	66,469.30	
64	$111,493.48	$55,747.00	19.21	15.92	21,413.77	8,875.19	
65	$116,481.16	$58,241.00	20.86	21.31	24,302.36	12,409.55	
66	$146,869.96	$73,435.00	20.50	20.14	30,114.08	14,788.12	

8.7 Transportation Systems

Transportation Systems results, selected in Figure 8-18 and shown in Figure 8-19, allow the user to view and map losses and damages to transportation systems, including **Highway**, **Railway**, **Light Rail**, **Bus**, **Port**, **Ferry**, and **Airport**. However, losses from flood will only be calculated for bridges and only as they relate to scour. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Figure 8-18: Results / Transportation Systems Menu

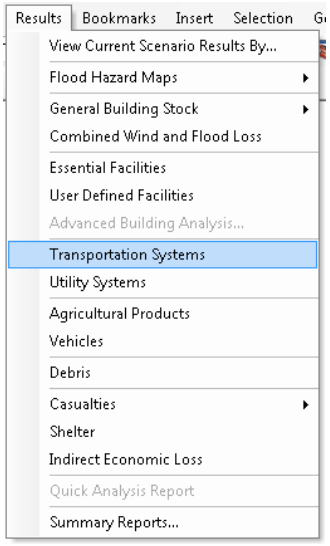
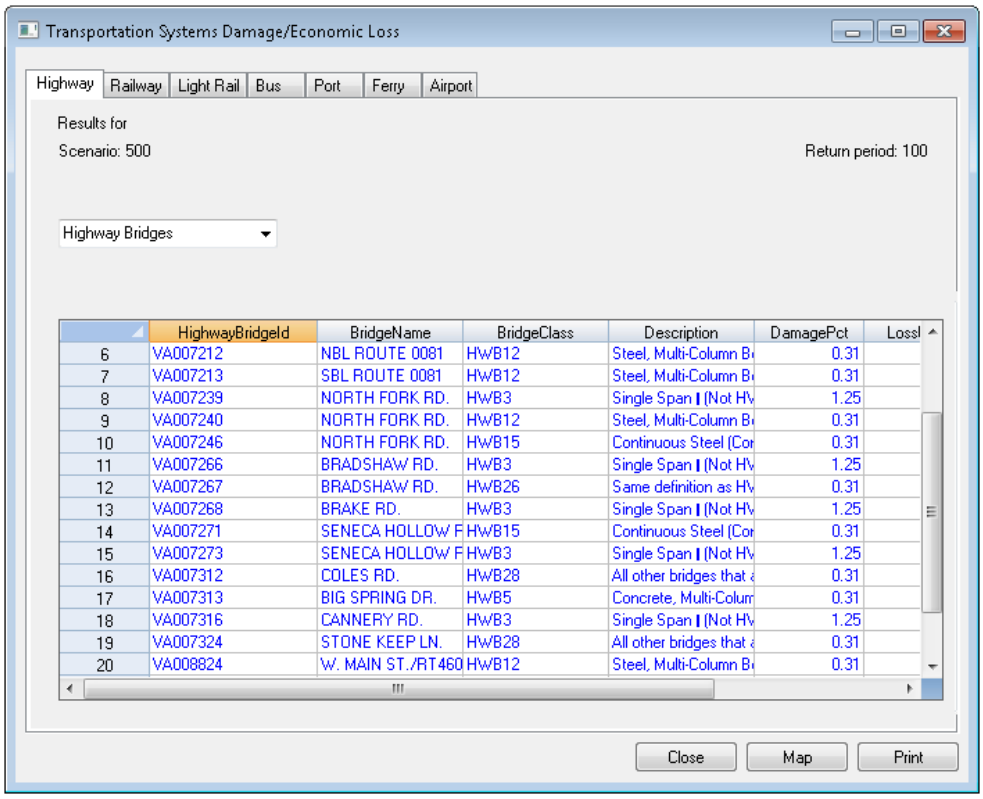


Figure 8-19: Transportation Systems Damage/Economic Loss (Highway) Table



8.8 Utility Systems

Utility Systems results, selected in Figure 8-20 and shown in Figure 8-21, allow the user to view and map losses and damages to utility systems, including **Potable Water**, **Waste Water**, **Oil**, **Natural Gas**, **Electric Power**, and **Communications**. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Figure 8-20: Results / Utility Systems Menu

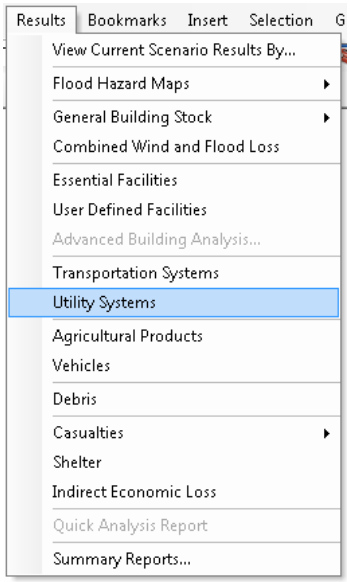
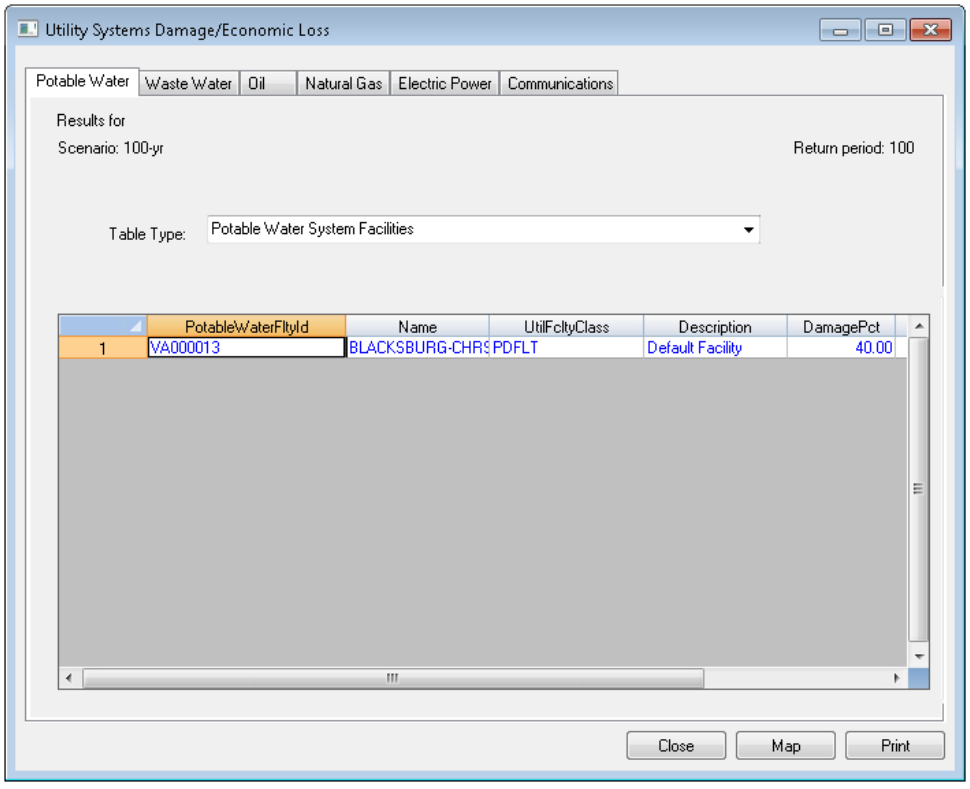


Figure 8-21: Utility Systems Damage/Economic Loss (Potable Water) Table



8.9 Agricultural Products

Agricultural Products results, selected in Figure 8-22 and shown in Figure 8-23, allow the user to view and map losses and damages to various crops by county. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Figure 8-22: Results / Agricultural Products Menu

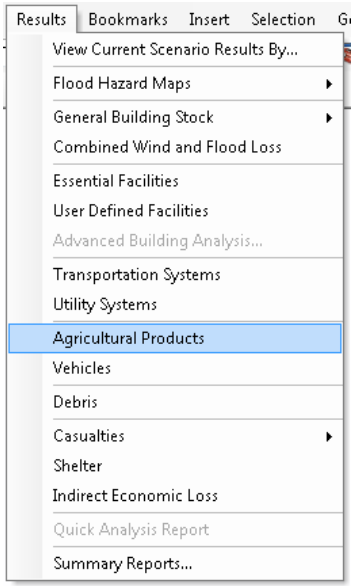
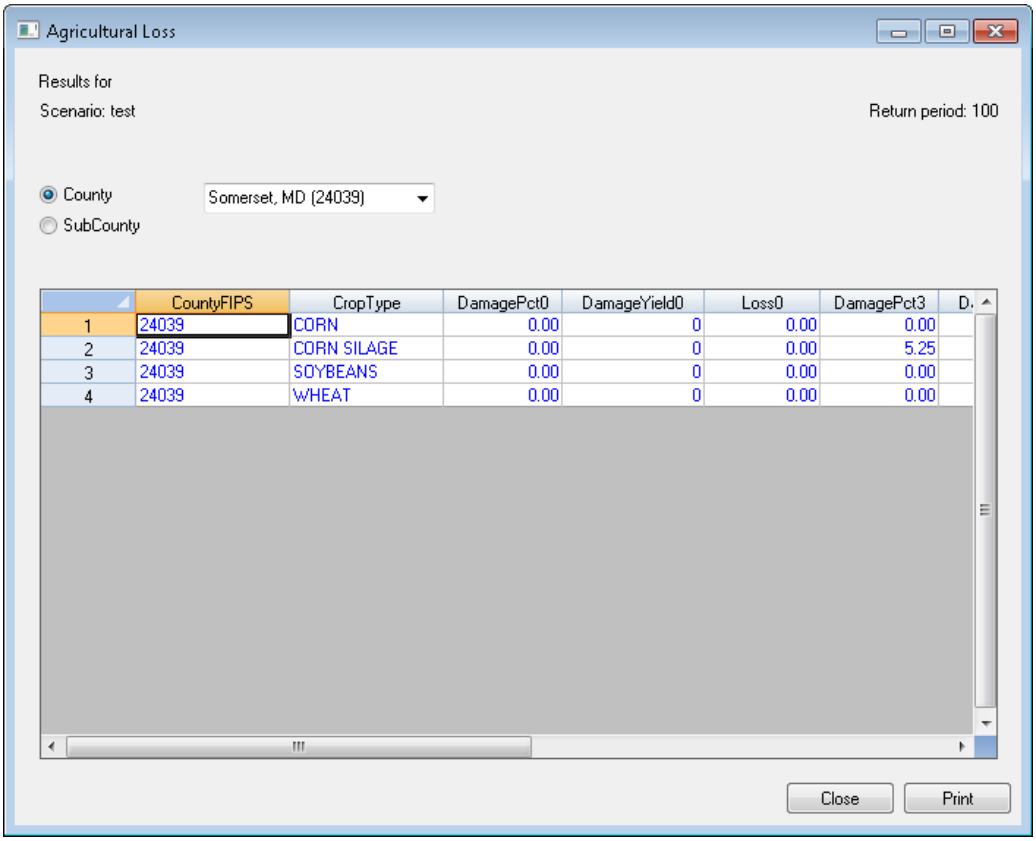


Figure 8-23: Agricultural Loss Table



8.10 Vehicles

Vehicles results, selected in Figure 8-24 and shown in Figure 8-25, allow the user to view and map losses and damages to vehicles by census block and for either night or day times. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Figure 8-24: Results / Vehicles Menu

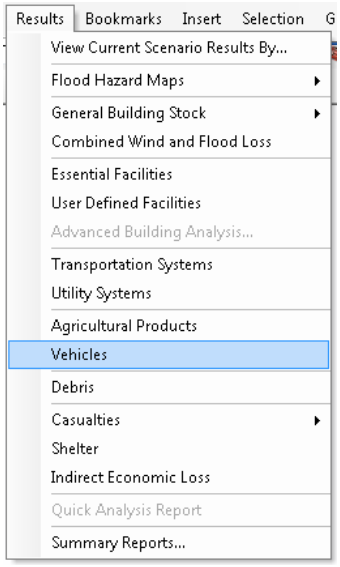
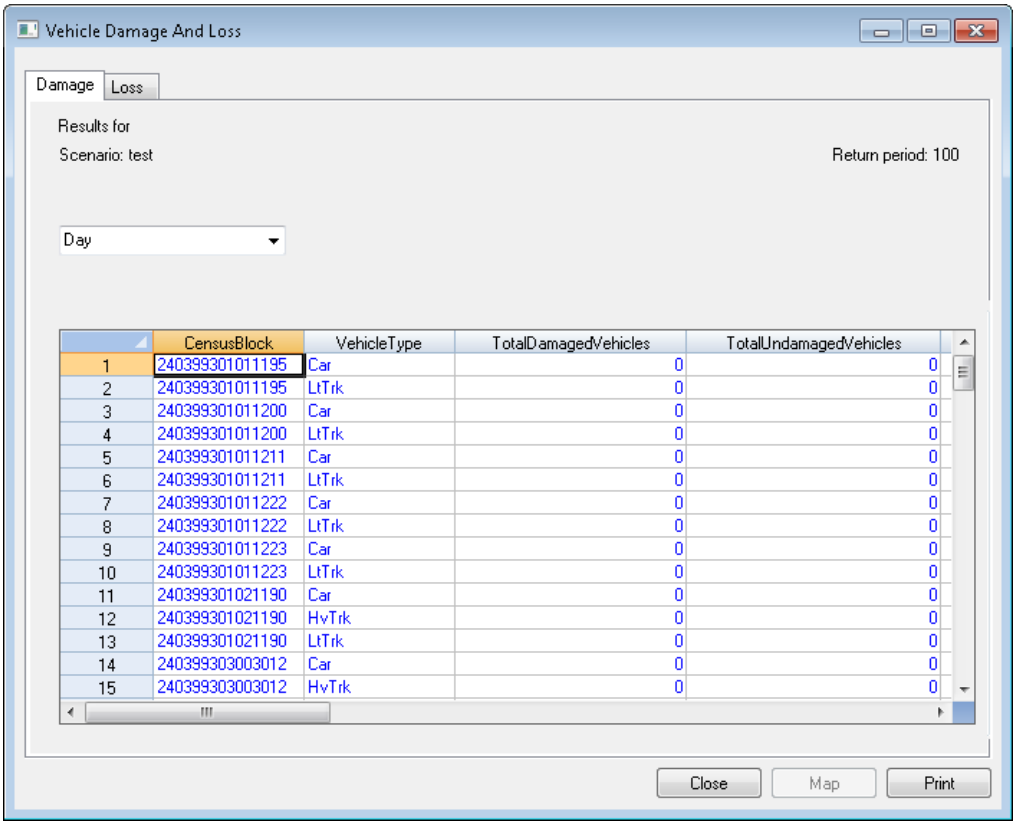


Figure 8-25: Vehicle Damage and Loss (Damage) Table



	CensusBlock	VehicleType	TotalDamagedVehicles	TotalUndamagedVehicles
1	240399301011195	Car	0	0
2	240399301011195	LtTrk	0	0
3	240399301011200	Car	0	0
4	240399301011200	LtTrk	0	0
5	240399301011211	Car	0	0
6	240399301011211	LtTrk	0	0
7	240399301011222	Car	0	0
8	240399301011222	LtTrk	0	0
9	240399301011223	Car	0	0
10	240399301011223	LtTrk	0	0
11	240399301021190	Car	0	0
12	240399301021190	HvTrk	0	0
13	240399301021190	LtTrk	0	0
14	240399303003012	Car	0	0
15	240399303003012	HvTrk	0	0

8.11 Debris

Debris results, selected in Figure 8-26 and shown in Figure 8-27, allow the user to view and map finish, structural, and foundation building debris results by census block. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Figure 8-26: Results / Debris Menu

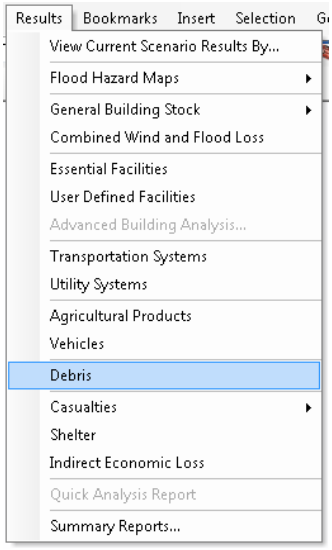
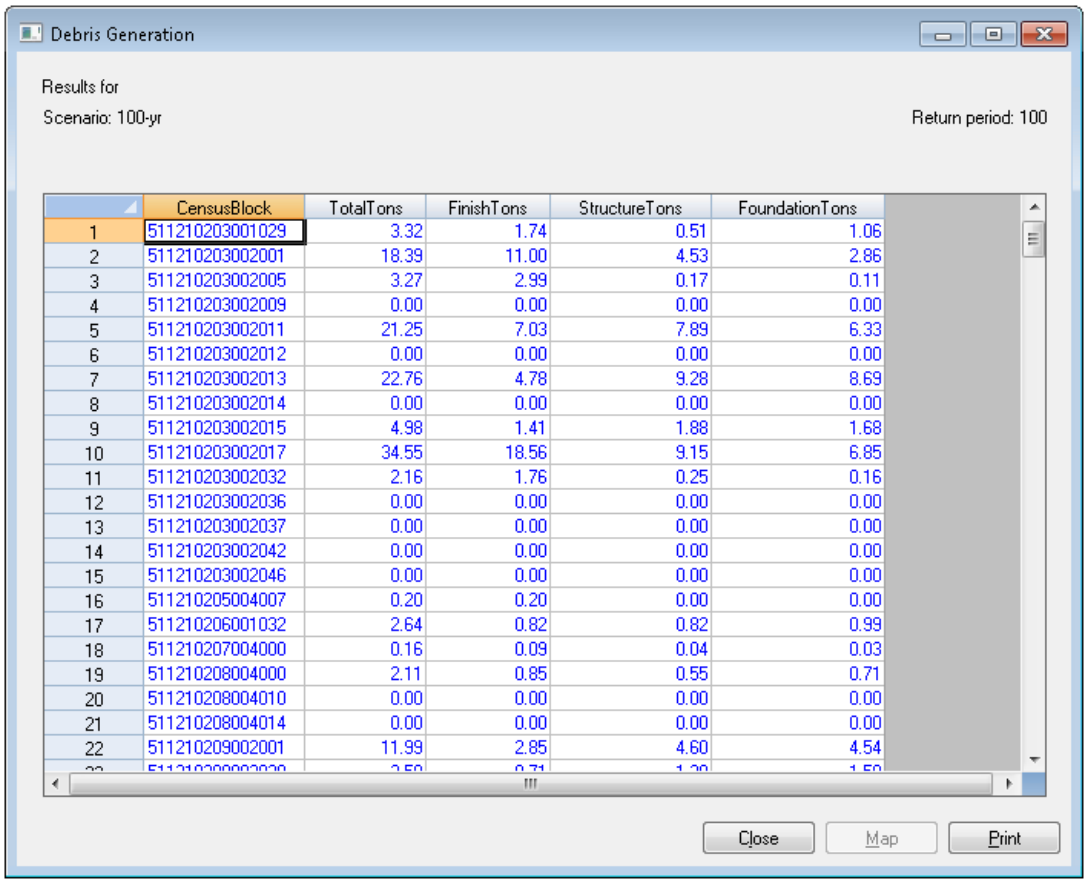


Figure 8-27: Debris Generation Table



	CensusBlock	TotalTons	FinishTons	StructureTons	FoundationTons
1	511210203001029	3.32	1.74	0.51	1.06
2	511210203002001	18.39	11.00	4.53	2.86
3	511210203002005	3.27	2.99	0.17	0.11
4	511210203002009	0.00	0.00	0.00	0.00
5	511210203002011	21.25	7.03	7.89	6.33
6	511210203002012	0.00	0.00	0.00	0.00
7	511210203002013	22.76	4.78	9.28	8.69
8	511210203002014	0.00	0.00	0.00	0.00
9	511210203002015	4.98	1.41	1.88	1.68
10	511210203002017	34.55	18.56	9.15	6.85
11	511210203002032	2.16	1.76	0.25	0.16
12	511210203002036	0.00	0.00	0.00	0.00
13	511210203002037	0.00	0.00	0.00	0.00
14	511210203002042	0.00	0.00	0.00	0.00
15	511210203002046	0.00	0.00	0.00	0.00
16	511210205004007	0.20	0.20	0.00	0.00
17	511210206001032	2.64	0.82	0.82	0.99
18	511210207004000	0.16	0.09	0.04	0.03
19	511210208004000	2.11	0.85	0.55	0.71
20	511210208004010	0.00	0.00	0.00	0.00
21	511210208004014	0.00	0.00	0.00	0.00
22	511210209002001	11.99	2.85	4.60	4.54

8.12 Casualties

The **Casualties** menu (Figure 8-28) allows the user to view result **By General Occupancy**. Select **By General Occupancy** to open a report in the default word processing program (Figure 8-29).

Figure 8-28: Results / Casualties Menu

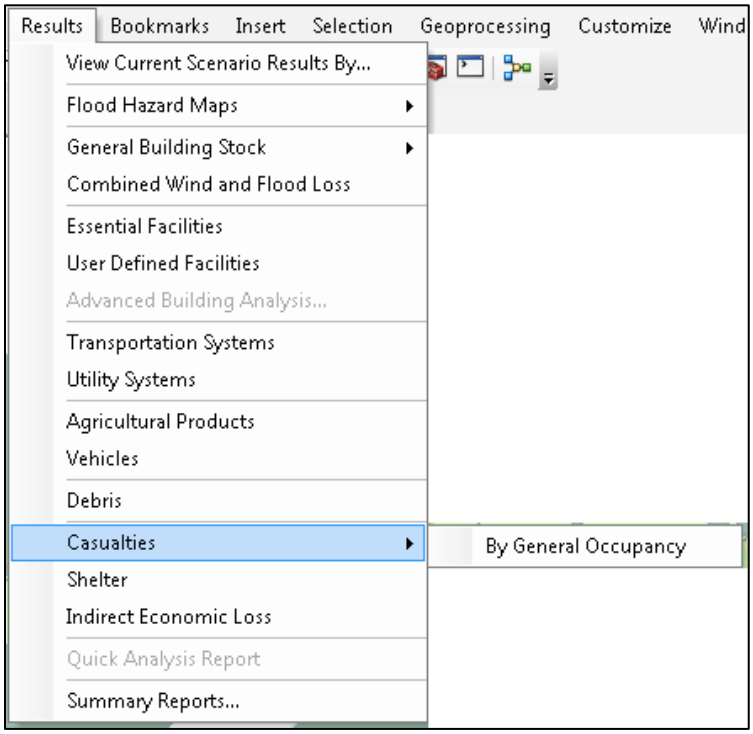
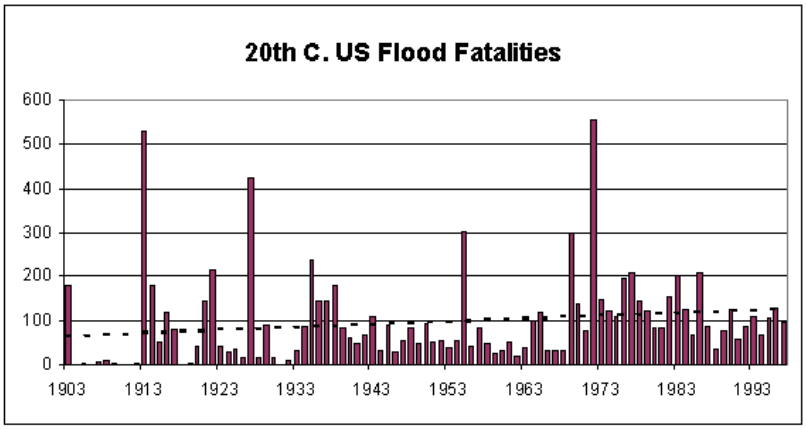


Figure 8-29: Casualties By General Occupancy Report

When the flood model was originally developed, an effort was made to develop methodology to estimate casualties due to flooding. Because there is limited data related to casualties beyond fatalities (i.e. injuries requiring hospitalization, minor injuries), the Flood Model Oversight Committee and FEMA decided to defer the estimation of casualties while further data collection and methodology development could continue. Below are two charts that can help the user assesses the likelihood of incurring casualties during a given flood event. It should be noted that the United States averages approximately 100 deaths per year due to flooding, although this has been increasing over the last few years. Figures 1 and 2 show US fatalities due to flooding, with an increasing trend which however, if normalized for population growth, appears to be relatively steady (FEMA, 1997).



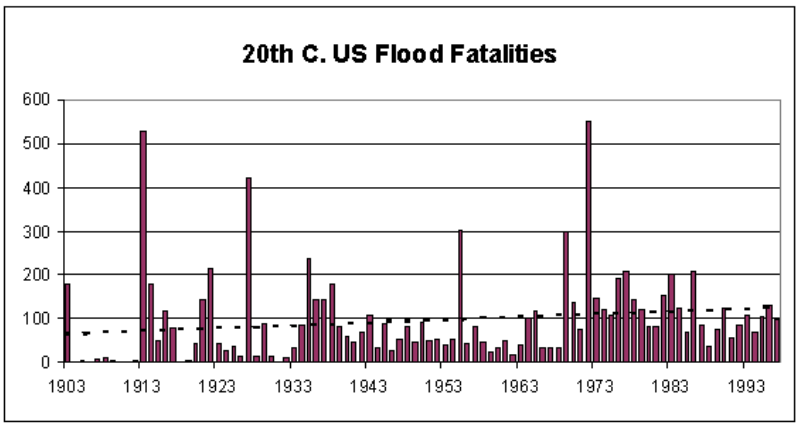


Figure 1 – 20th Century US Flood Fatalities

source: NOAA Hydrologic Information Center

8.13 Shelter

Shelter results, selected in Figure 8-30 and shown in Figure 8-31, allow the user to view and map the estimated displaced population and the short-term shelter needs by census block. See Section 8.3.5 for general methods to create maps and export data from the Flood Model results.

Figure 8-30: Results / Shelter Menu

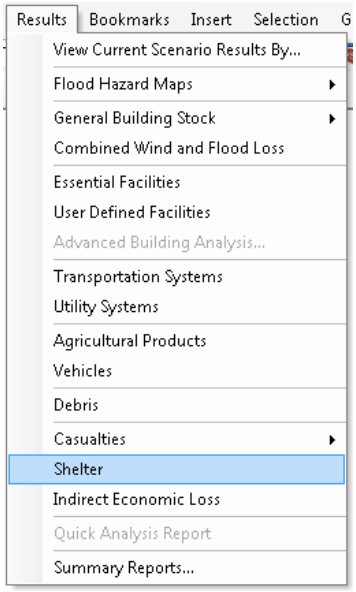
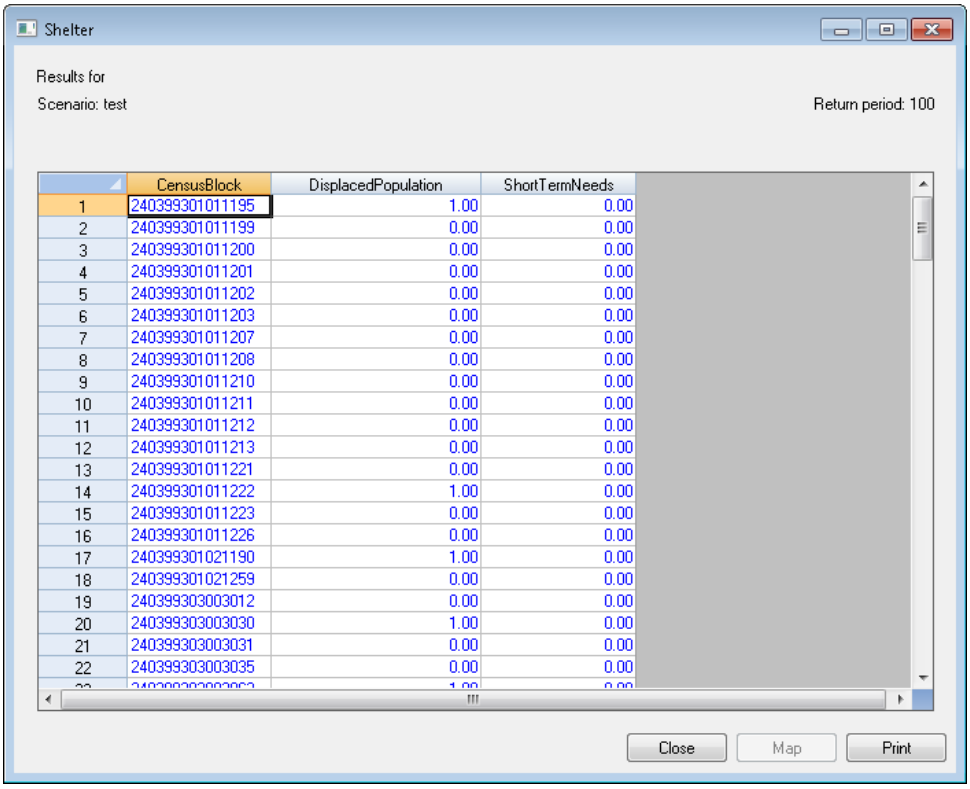


Figure 8-31: Shelter Table



	CensusBlock	DisplacedPopulation	ShortTermNeeds
1	240399301011195	1.00	0.00
2	240399301011199	0.00	0.00
3	240399301011200	0.00	0.00
4	240399301011201	0.00	0.00
5	240399301011202	0.00	0.00
6	240399301011203	0.00	0.00
7	240399301011207	0.00	0.00
8	240399301011208	0.00	0.00
9	240399301011210	0.00	0.00
10	240399301011211	0.00	0.00
11	240399301011212	0.00	0.00
12	240399301011213	0.00	0.00
13	240399301011221	0.00	0.00
14	240399301011222	1.00	0.00
15	240399301011223	0.00	0.00
16	240399301011226	0.00	0.00
17	240399301021190	1.00	0.00
18	240399301021259	0.00	0.00
19	240399303003012	0.00	0.00
20	240399303003030	1.00	0.00
21	240399303003031	0.00	0.00
22	240399303003035	0.00	0.00

8.14 Indirect Economic Loss

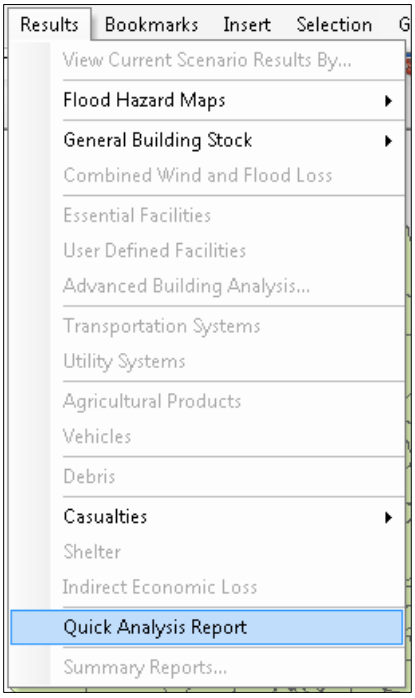
The **Indirect Economic Loss Results** window is inactive in Hazus and will not produce any results.

8.15 Quick Analysis Report

Chapter 13 has step-by-step instructions on how to perform **Quick Look** and **Enhanced Quick Look** analyses.

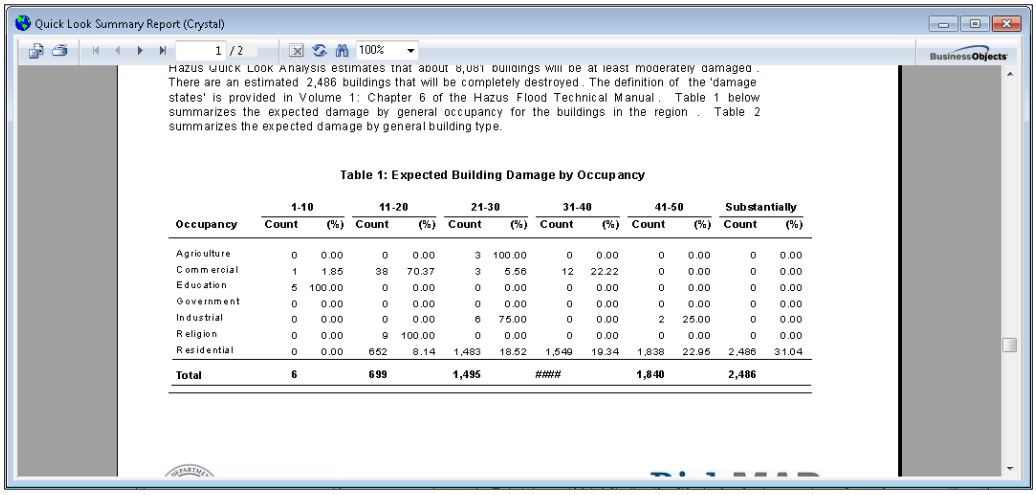
After running the loss analysis for **Quick Look** or **Enhanced Quick Look**, the user will be able to review the loss results by generating a special report exclusively for the Quick Analysis. This report is created by selecting **Quick Analysis Report** from the **Results** menu (Figure 8-32). This report provides the only way to access the loss results for a **Quick Analysis**.

Figure 8-32: Quick Analysis Report Menu



The **Quick Look Summary Report** (Figure 8-33) consists of a two-page report summarizing the GBS results.

Figure 8-33: Quick Analysis Report



Hazus Quick Look Analysis estimates that about 8,081 buildings will be at least moderately damaged. There are an estimated 2,486 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 6 of the Hazus Flood Technical Manual. Table 1 below summarizes the expected damage by general occupancy for the buildings in the region. Table 2 summarizes the expected damage by general building type.

Table 1: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	0	0.00	0	0.00	3	100.00	0	0.00	0	0.00	0	0.00
Commercial	1	1.85	38	70.37	3	5.56	12	22.22	0	0.00	0	0.00
Education	5	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	6	75.00	0	0.00	2	25.00	0	0.00
Religion	0	0.00	9	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	652	8.14	1,483	18.52	1,549	19.34	1,838	22.95	2,486	31.04
Total	**6**		**699**		**1,495**		**####**		**1,840**		**2,486**	

8.16 Summary Reports

The **Summary Reports** results, selected in Figure 8-34 and shown in Figure 8-35, allow the user to view and print a wide variety of reports on topics, including **Inventory**, **Buildings**, **Lifelines**, and **Losses**. The reports are created using the Crystal Reports engine that is included as part of Hazus installation. Figure 8-36 and Figure 8-37 show examples of the many reports available, as listed in Table 8-1. Figure 8-37 shows the report-viewing window in Hazus, which contains icons along the top to export or print reports and navigate through report pages. For example, the left-most icon (as shown in Figure 8-36) allows the user to export a report in pdf format. Figure 8-38 shows the export window for the user to select the report export format and file location.

Figure 8-34: Results / Summary Reports Menu

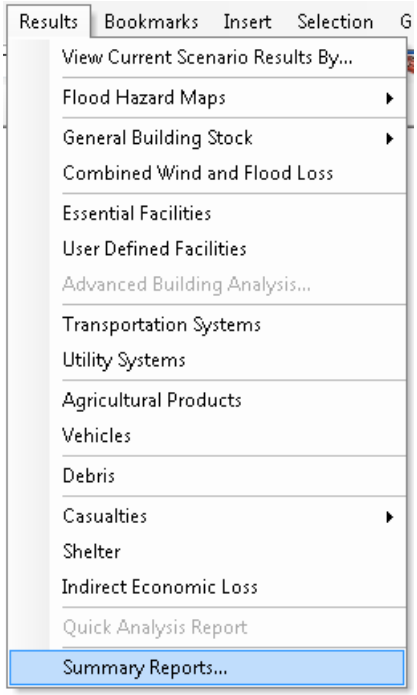


Figure 8-35: Summary Reports (Inventory) Window

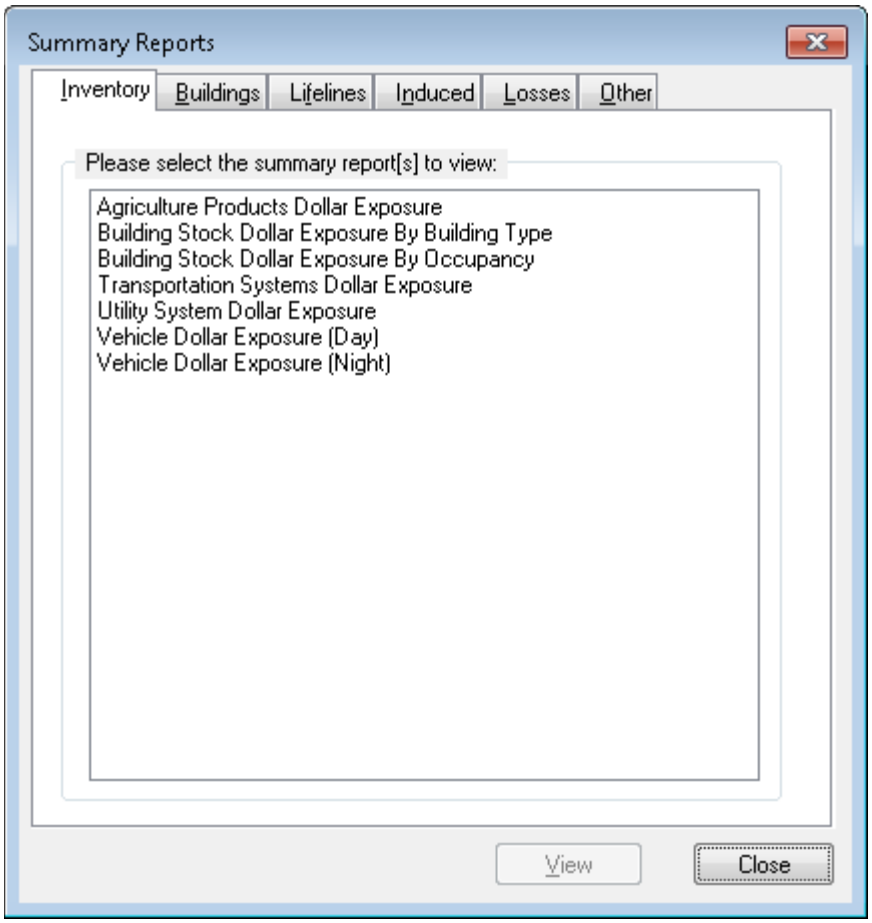


Figure 8-36: Example – Agriculture Products Dollar Exposure Summary Report

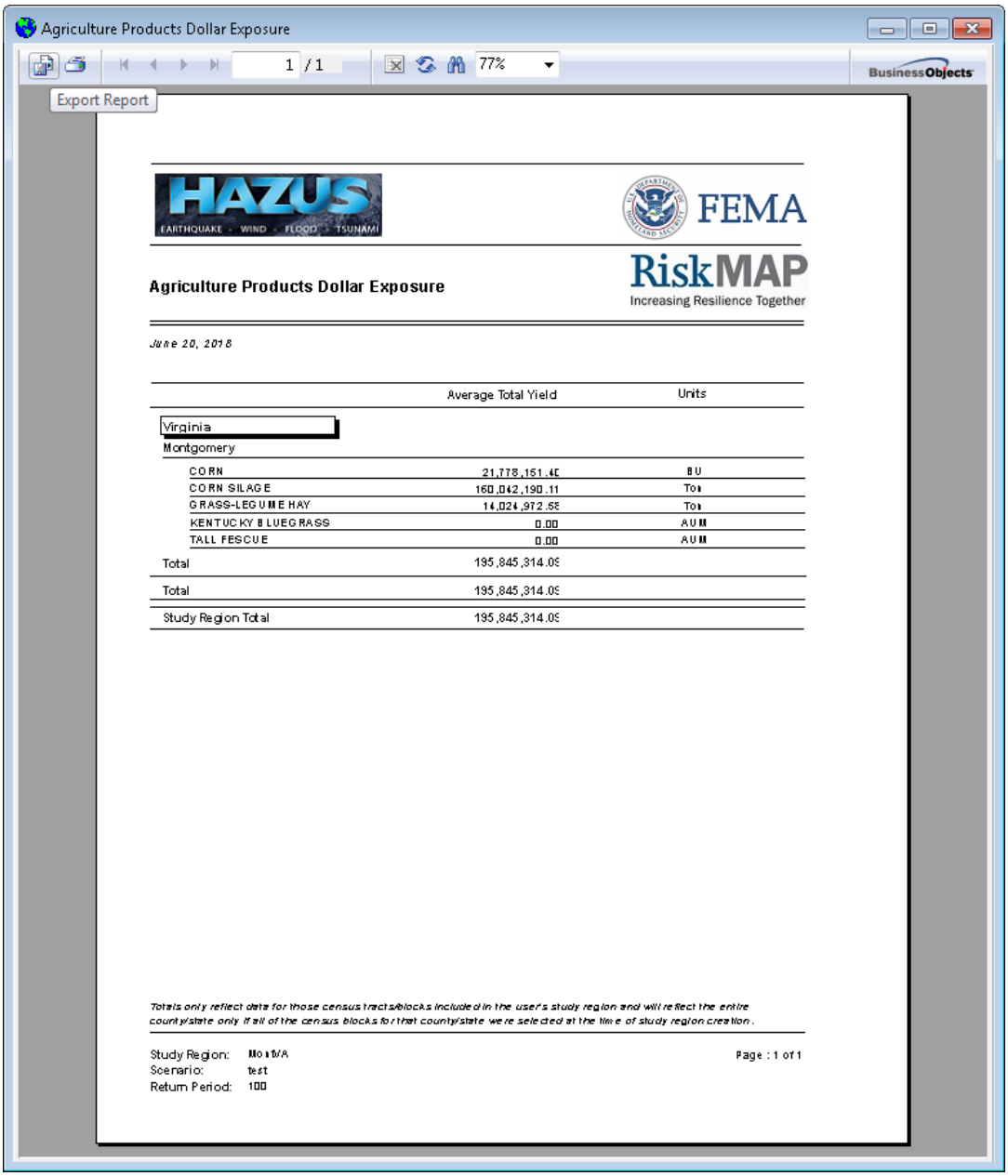
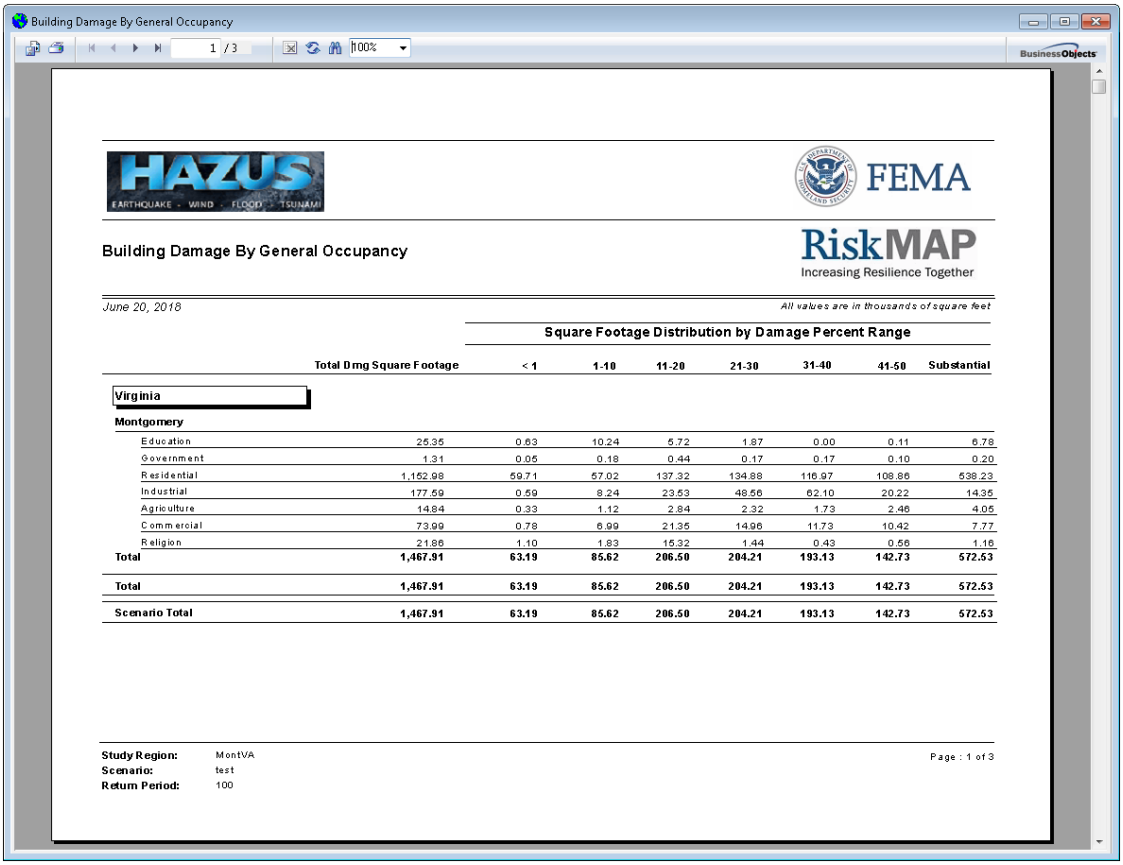


Figure 8-37: Example – Building Damage By General Occupancy Summary Report



Building Damage By General Occupancy

HAZUS EARTHQUAKE - WIND - FLOOD - TSUNAMI

FEMA

RiskMAP
Increasing Resilience Together

Building Damage By General Occupancy

June 20, 2018

All values are in thousands of square feet

		Square Footage Distribution by Damage Percent Range						
	Total Dmg Square Footage	< 1	1-10	11-20	21-30	31-40	41-50	Substantial
Virginia								
Montgomery								
Education	25.35	0.63	10.24	5.72	1.87	0.00	0.11	6.78
Government	1.31	0.05	0.18	0.44	0.17	0.17	0.10	0.20
Residential	1,152.98	59.71	57.02	137.32	134.88	116.97	108.86	538.23
Industrial	177.59	0.59	8.24	23.53	48.56	62.10	20.22	14.35
Agriculture	14.84	0.33	1.12	2.84	2.32	1.73	2.46	4.05
Commercial	73.99	0.78	6.99	21.35	14.96	11.73	10.42	7.77
Religion	21.86	1.10	1.83	15.32	1.44	0.43	0.56	1.16
Total	**1,467.91**	**63.19**	**85.62**	**206.50**	**204.21**	**193.13**	**142.73**	**572.53**
Total	**1,467.91**	**63.19**	**85.62**	**206.50**	**204.21**	**193.13**	**142.73**	**572.53**
Scenario Total	**1,467.91**	**63.19**	**85.62**	**206.50**	**204.21**	**193.13**	**142.73**	**572.53**

Study Region: MontVA
Scenario: test
Return Period: 100

Page : 1 of 3

Figure 8-38: Report Export

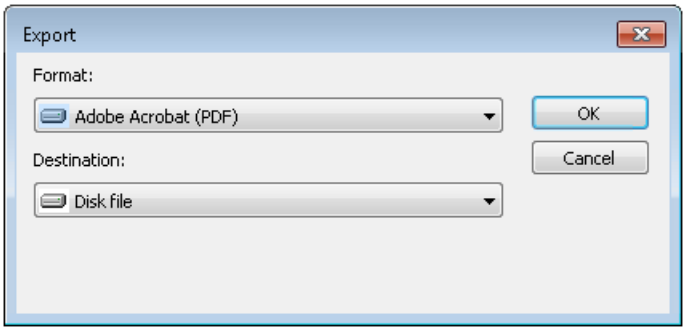


Table 8-1: List of Summary Reports

Tab	Report	Description
Inventory	Agricultural Products Dollar Exposure	Dollar exposure (in thousands of dollars) of the agricultural products in the Study Region.
Inventory	Building Stock Dollar Exposure by Building Type	Dollar exposure (in thousands of dollars) of the building stock by building type in the Study Region.
Inventory	Building Stock Dollar Exposure by Occupancy	Dollar exposure (in thousands of dollars) of the building stock by occupancy in the Study Region.
Inventory	Transportation Systems Dollar Exposure	Dollar exposure (in thousands of dollars) of the transportation systems in the Study Region.
Inventory	Utility System Dollar Exposure	Dollar exposure (in thousands of dollars) of the utility system in the Study Region.
Inventory	Vehicle Dollar Exposure (Day)	Dollar exposure (in thousands of dollars) of vehicles (during the day) in the Study Region.
Inventory	Vehicle Dollar Exposure (Night)	Dollar exposure (in thousands of dollars) of vehicles (during the night) in the Study Region.
Buildings	Building Damage by Building Type	Building damage (square footage distribution by percent damage) by building type caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage by General Occupancy	Building damage (square footage distribution by percent damage) by general occupancy caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage by General Occupancy (Post-FIRM)	Building damage (square footage distribution by percent damage) by general occupancy (Post-FIRM) caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage by General Occupancy (Pre-FIRM)	Building damage (square footage distribution by percent damage) by general occupancy (Pre-FIRM) caused by the hazard in the scenario. All values are in thousands of square feet.
Buildings	Building Damage Count by General Building Type	Building damage (building count by percent damage) by general building type caused by the hazard in the scenario.
Buildings	Building Damage Count by General Occupancy	Building damage (building count by percent damage) by general occupancy caused by the hazard in the scenario.

Tab	Report	Description
Buildings	Building Damage Count by General Occupancy (Post-FIRM)	Building damage (building count by percent damage) by general occupancy (Post-FIRM) caused by the hazard in the scenario.
Buildings	Building Damage Count by General Occupancy (Pre-FIRM)	Building damage (building count by percent damage) by general occupancy (Pre-FIRM) caused by the hazard in the scenario.
Buildings	Emergency Operation Center Damage & Functionality	Damage and functionality of Emergency Operation Center caused by the hazard in the scenario.
Buildings	Fire Station Damage & Functionality	Damage and functionality of Fire Stations caused by the hazard in the scenario.
Buildings	Hospital Damage & Functionality	Damage and functionality of Hospitals caused by the hazard in the scenario.
Buildings	Police Station Damage & Functionality	Damage and functionality of Police Stations caused by the hazard in the scenario.
Buildings	School Damage & Functionality	Damage and functionality of Schools caused by the hazard in the scenario.
Lifelines	Highway Bridge Damage & Functionality	Damage and functionality of Highway Bridges caused by the hazard in the scenario.
Lifelines	Light Rail Bridge Damage & Functionality	Damage and functionality of Light Rail Bridges caused by the hazard in the scenario.
Lifelines	Potable Water Facility Damage	Damage to Potable Water Facilities caused by the hazard in the scenario.
Lifelines	Railroad Bridge Damage & Functionality	Damage and functionality of Railroad Bridges caused by the hazard in the scenario.
Lifelines	Wastewater Facility Damage	Damage to Wastewater Facilities caused by the hazard in the scenario.
Induced	Debris Generated	Estimated total of debris generated (in tons) by the hazard in the scenario.
Losses	Annualized Direct Economic Losses for Buildings	Annualized direct economic losses (in thousands of dollars) for buildings resulting from the hazard in the scenario.
Losses	Combined Wind and Surge Loss	Direct economic losses (in thousands of dollars) for the combined results from wind and flood hazards in a storm surge scenario.
Losses	Depreciated Direct Economic Losses for Buildings	Depreciated direct economic losses (in thousands of dollars) for buildings resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Agricultural Products	Direct economic losses (in thousands of dollars) for agricultural products resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Buildings	Direct economic losses (in thousands of dollars) for buildings resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Transportation	Direct economic losses (in thousands of dollars) for transportation resulting from the hazard in the scenario.
Losses	Direct Economic Losses for UDFs	Direct economic losses for user-defined facilities (UDFs) resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Utilities	Direct economic losses (in thousands of dollars) for utilities resulting from the hazard in the scenario

Tab	Report	Description
Losses	Direct Economic Losses for Vehicles (Day)	Direct economic losses (in thousands of dollars for vehicles (during the day) resulting from the hazard in the scenario.
Losses	Direct Economic Losses for Vehicles (Night)	Direct economic losses (in thousands of dollars) for vehicles (during the night) resulting from the hazard in the scenario.
Losses	Indirect Economic Impact with Aid	Income and Employment impact (in millions of dollars) with outside aid resulting from the hazard in the scenario.
Losses	Indirect Economic Impact without Aid	Income and Employment impact (in millions of dollars) without outside aid resulting from the hazard in the scenario.
Losses	Shelter Requirements	Estimated number of households that are expected to be displaced; and of those households, estimated number of people to seek temporary shelter in public shelters as a result of the hazard in the scenario.
Other	Flood Global Risk Report	Includes general description of the region, building exposure by occupancy type (one for the Study Region and another for the scenario), expected building damage by occupancy and expected building damage by building type, expected damage to Essential Facilities, debris generated, shelter requirements, building-related economic loss estimates, and regional population and building value data.
Other	Quick Assessment	Includes regional statistics (area in square miles, number of census blocks, number of buildings, number of people in the region, building exposure) and scenario results (shelter requirements and economic loss)

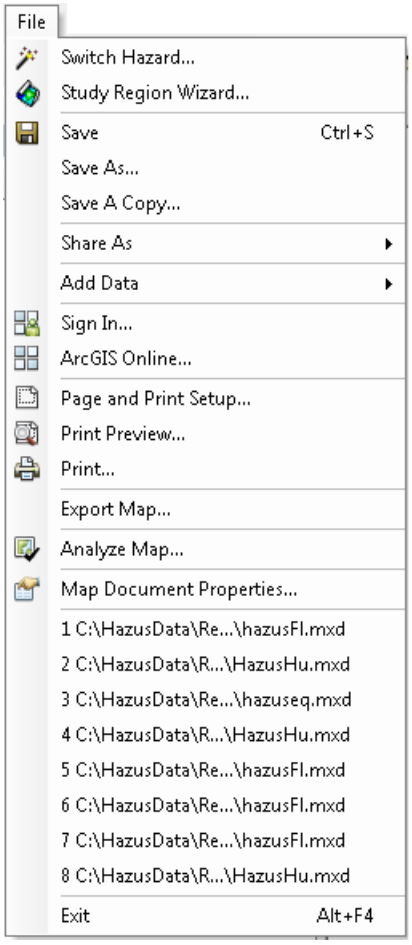
9 Model Menu: Other Items

This section addresses the **File** menu, the **Help** menu, and the **Customize** menu. The primary focus is on any menu items that are different in the Hazus version of ArcMap compared with a typical ArcMap instance.

9.1 File Menu

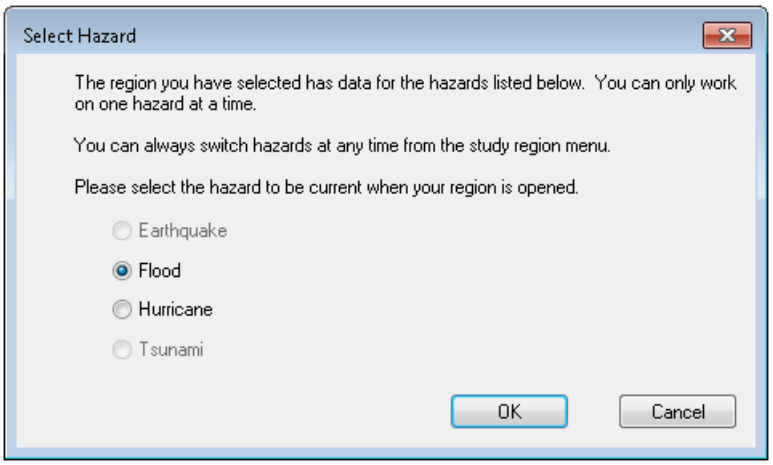
The **File** menu, shown in Figure 9-1, is largely the same as the usual ArcMap File menu. The only two differences are the first two items: **Switch Hazard…** and **Study Region Wizard…**.

Figure 9-1: Hazus File Menu



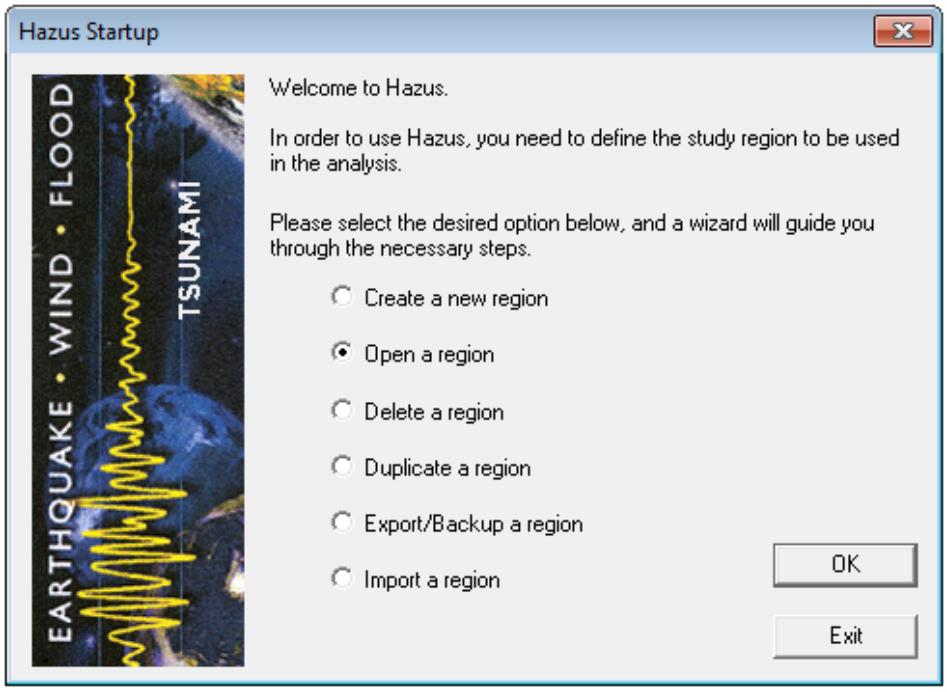
The **Switch Hazard** option opens the **Select Hazard** dialog (Figure 9-2), which allows the user to switch between hazard types if the region was created with multiple hazards. Figure 9-2 shows an example related to storm surge where the Study Region has data and analyses for both the Hurricane Model and the Flood Model. When the user selects a new hazard, ArcMap will close and re-open with the selected hazard.

Figure 9-2: Select Hazard Dialog



The **Study Region Wizard…** option opens the Hazus startup screen (Figure 9-3). The only option available is **Open a region**. Click **OK** to select from any of the previously created regions and launch ArcMap.

Figure 9-3: Study Region Wizard



The remaining File menu options are the same as those normally found in ArcMap. Please refer to ESRI documentation for any questions regarding these options.

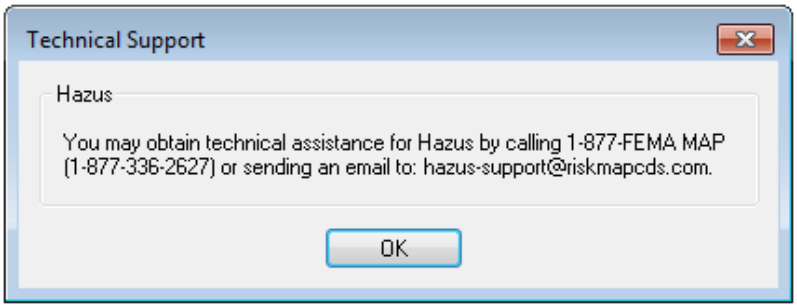
9.2 Help Menu

The **Help** menu, shown in Figure 9-4, is largely the same as the usual ArcMap Help menu. The only two differences are the **Obtaining Technical Support…** and **About Hazus-MH** options.

Figure 9-4: Hazus Help Menu

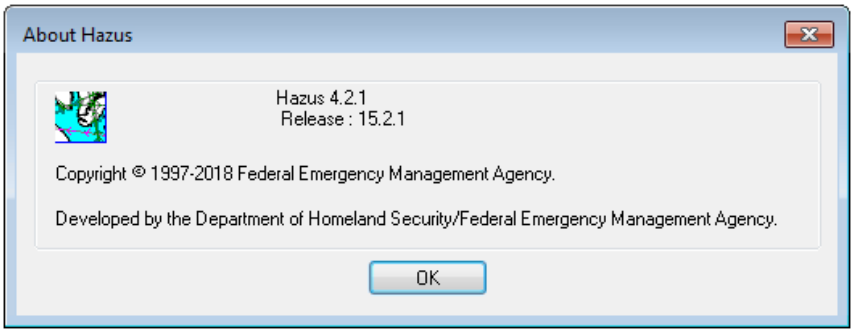
Selecting the **Obtaining Technical Support…** option will open the **Technical Support** window (Figure 9-5), which provides a phone number and email address for the user to refer any technical questions regarding Hazus.

Figure 9-5: Technical Support Window



Selecting the **About Hazus-MH** option will open the **About Hazus-MH** window (Figure 9-6), which shows the copyright information for Hazus.

Figure 9-6: About Hazus Window

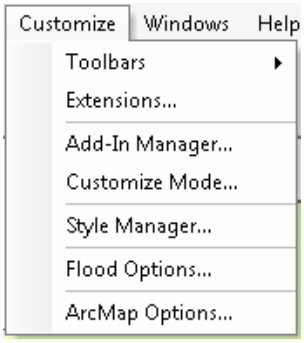


The remaining options on the Help menu are the same as those normally found in ArcMap. Please refer to Esri documentation for any questions regarding these options.

9.3 Customize Menu

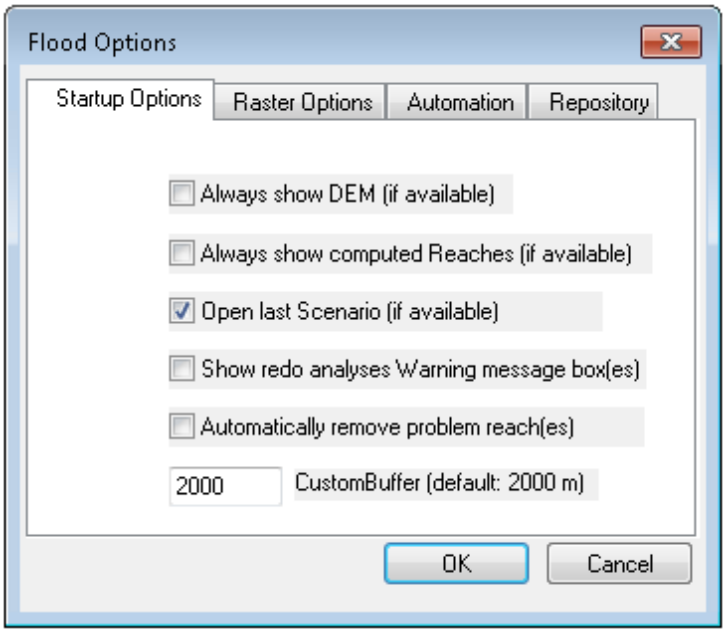
The **Customize** menu, shown in Figure 9-7, is largely the same as the usual ArcMap Customize menu. The only addition to the menu is **Flood Options…**.

Figure 9-7: Hazus Customize Menu



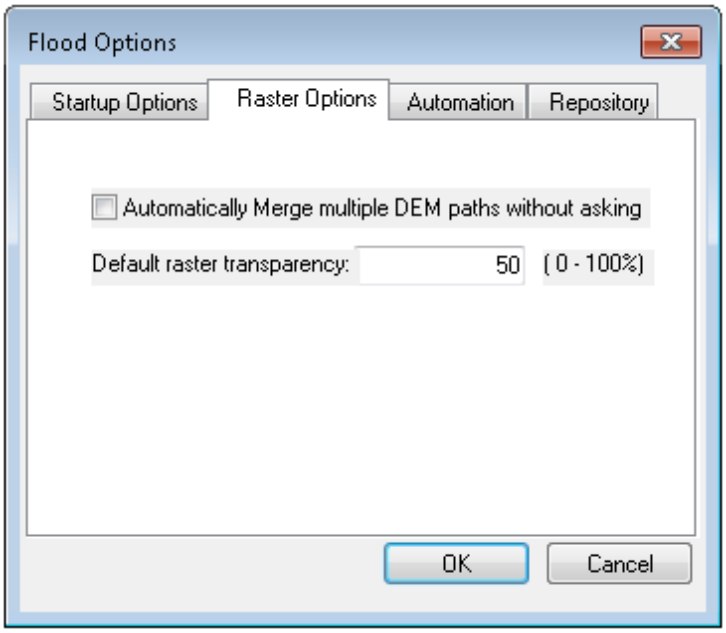
Selecting **Flood Options…** will open the **Flood Options** window (Figure 9-8), which has four tabs: **Startup Options** (Figure 9-8), **Raster Options** (Figure 9-9), **Automation** (Figure 9-10), and **Repository** (Figure 9-11). The **Startup Options** tab gives the user some choices of what will appear when a Hazus ArcMap document is launched.

Figure 9-8: Flood Options (Startup Options) Window



The **Raster Options** tab gives the user control over how rasters will be symbolized and displayed in the Table of Contents.

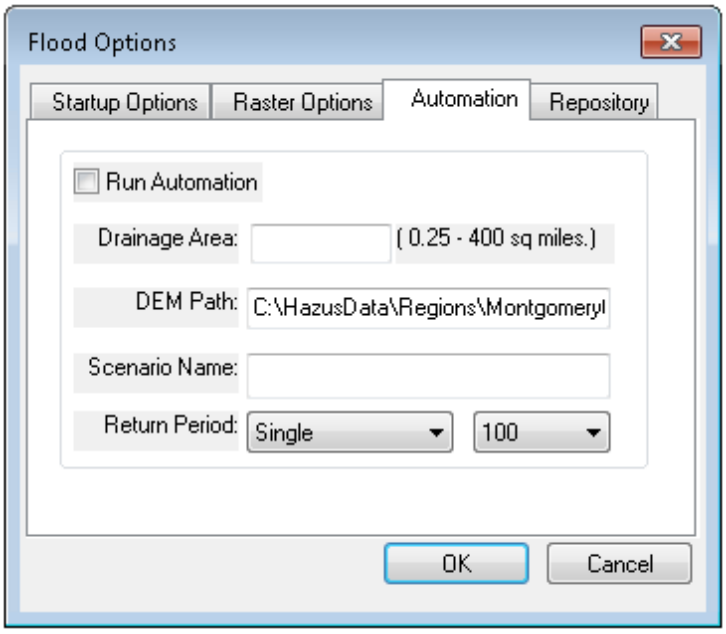
Figure 9-9: Flood Options (Raster Options) Window



The **Automation** tab (**Figure 9-10**) allows the user the set the parameters for a scenario to run from stream networks. To run:

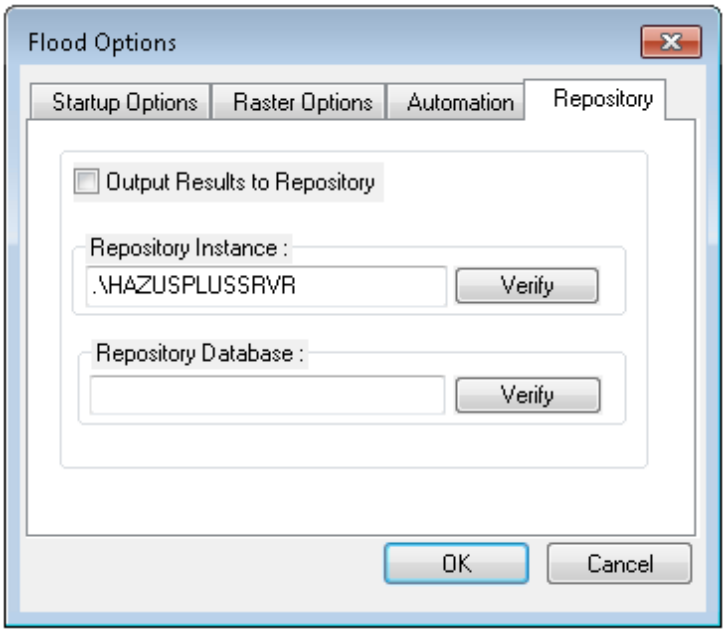
1. Select the **Run Automation** checkbox.
2. Enter the **Drainage Area** for the Study Region.
3. **DEM Path** is automatically included based on the previous DEM analysis. Editing the path will have no effect on the DEM or **DEM Path**.
4. Enter a **Scenario Name** (the name must be unique). All reaches that are developed by the stream network will be selected and included in the scenario.
5. Select a **Return Period**. If the user selects the **Single** return period, Hazus will run through the GBS analysis. If the user selects the **Suite** option, Hazus will run through the GBS analysis *and* the AAL analysis.
6. Click **OK.**

Figure 9-10: Flood Options (Automation) Window



The **Repository** tab allows the user to control where output data is stored.

Figure 9-11: Flood Options (Repository) Window

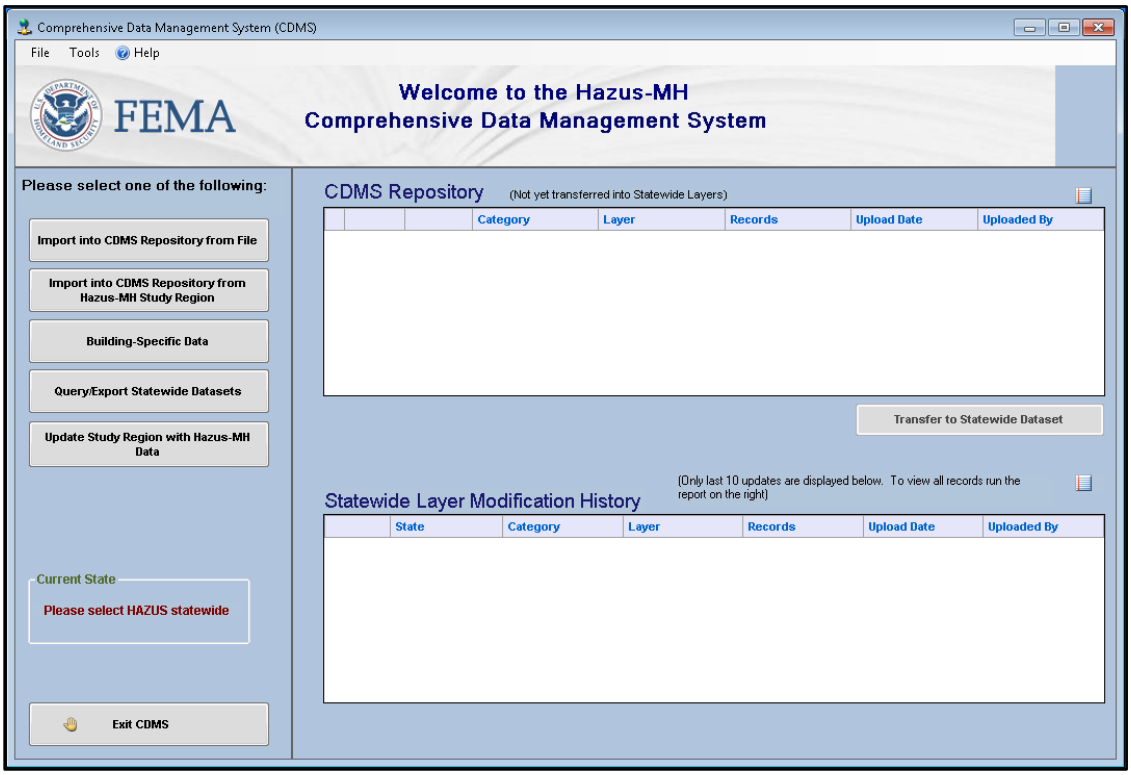


The remaining items on the **Customize** menu are the same as those normally found in ArcMap. Please refer to ESRI documentation for any questions regarding these options.

10 Advanced Hazus Analysis: User-Defined Inventory Data

The Hazus default data inventory provides many datasets that support analysis, but in certain areas, a custom dataset may be more relevant to the Study Region being analyzed. Although Hazus data for a given location includes default inventory data for most data types, users may want to edit existing data or input their own data for certain type of analysis. The recommendation to users is to perform all data editing and entry using the Hazus Comprehensive Data Management System (CDMS) (Figure 10-1). CDMS will use Hazus Flood Model default values when critical attributes have not been populated (see Section 10.1 for default values). When CDMS is used to update the user-defined inventory data at the state level, these updated data will automatically be included in any Hazus Study Regions for that state. Details on using CDMS and data requirements can be found in the *Hazus Comprehensive Data Management System User Guidance*.

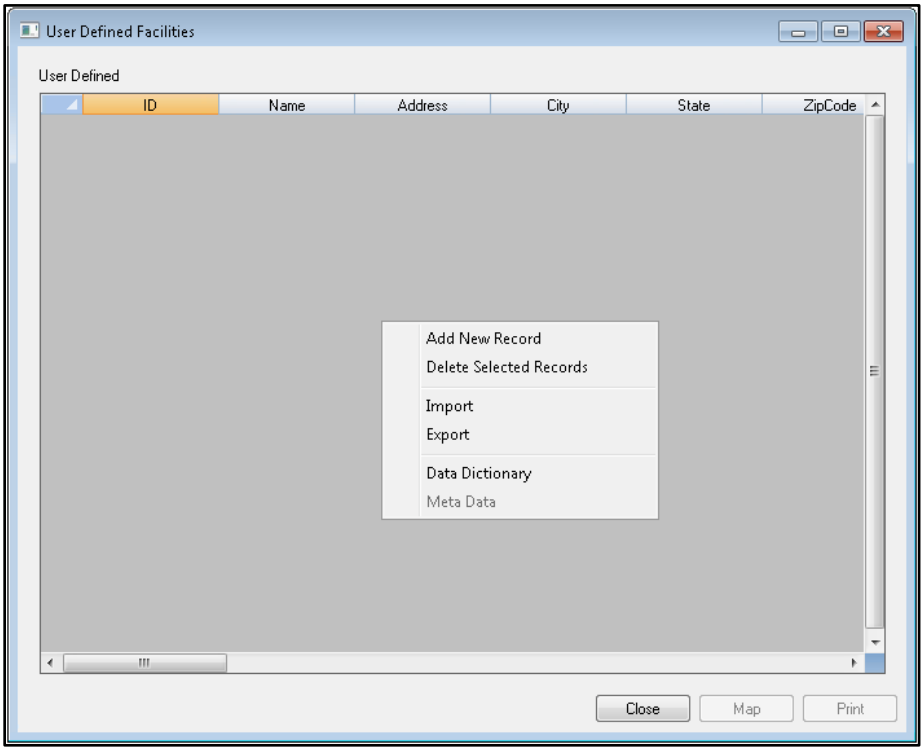
Figure 10-1: Hazus Comprehensive Data Management System



The Hazus Flood Model allows users to edit or import their own data. For example, **User-Defined Facilities**, which appears on the **Inventory menu**, allows the user to enter user-specific data sets to be analyzed through Hazus for more accurate results. The user will need to develop, external to Hazus, custom data for individual structures. For import into Hazus, these data need to be converted to a personal geodatabase (the only format Hazus currently supports for import).

To import the data, select **User-Defined Facilities** from the **Inventory** menu. The **User-Defined Structure Inventory** window (Figure 10-2) will open. Right click in the (empty) table to get the context menu. Select **Start Editing** and then **Import**.

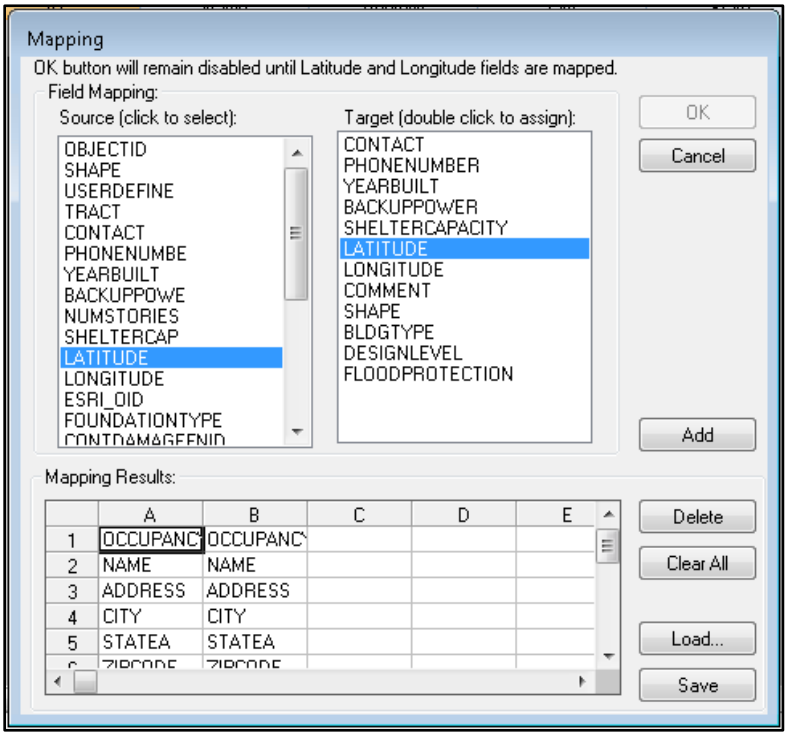
Figure 10-2: User-Defined Facilities Table



Navigate to the geodatabase (.mdb) with the data. Hazus will number the tables that are in the geodatabase and ask the user which table to use. The input file must be a point feature class within the .mdb.

Because the input data could be in any schema, Hazus will open the **Mapping** dialog to allow the user to convert the data from the input format to the target format, as shown in Figure 10-3. The list of fields in the input table will be shown on the left and will vary because the data inputs will be defined by the user. The list of the target fields will be shown on the right. This is the most critical step in the import process because it affects the data used and therefore the results obtained.

Figure 10-3: Mapping UDF Data Fields



10.1 UDF-Required Attributes

Table 10-1 presents the attributes required for analysis of UDFs within the Flood Model. If any of the attributes are not imported (i.e., mapped), Hazus will populate them with default values. Although those values can be edited later through the Hazus interface, doing so is not practical for such a large number of records. Therefore, having the correct values in the imported file is more efficient than editing them later.

Table 10-1: UDF Attribute Descriptions

Attribute	Description	Minimum Requirement	Field Type	Comments
ID	Hazus-assigned unique identifier for each record	Yes (generated by Hazus)	Text, Length: 8	If the user wants to include their own unique identifier for each structure, suggested fields are “Name” and “Comment.”
Name	Structure name	No	Text, Length: 40	This field can be used for user’s unique identifier for each structure, which may be local parcel ID if available.
Address	Structure street address	No	Text, Length: 40	
City	Structure city	No	Text, Length: 40	

Attribute	Description	Minimum Requirement	Field Type	Comments
State	Structure state	No	Text, Length: 2	
ZipCode	Structure zip code	No	Text, Length: 10	
Contact	Structure additional contact	No	Text, Length: 40	
Phone	Structure phone	No	Text, Length: 14	
Occupancy	Hazus-specific occupancy type	Yes	Text, Length: 5	Hazus will assume RES1 if unpopulated. See Hazus technical manuals or Hazus Inventory menu for detailed list of Hazus-specific occupancies.
BldgType	Building type per the Hazus model building types for flood	No	Text, Length: 15	Acceptable values are “Concrete,” “ManufHousing,” “Masonry,” “Steel,” and “Wood.”
Cost	Building replacement cost = cost to replace the building in case of damage in whole dollars (not thousands)	Yes	Money, Length: 8, Precision: 19, Scale: 4	Primary source should be cost-estimating guides, such as RSMeans ($/sqft), along with local square footage values from appraisal office (not local assessed or appraised values from these offices).
YearBuilt	Year structure was built	No	Smallint, Length: 2, Precision: 5	
Area	Building finished floor area in square feet	No	Real, Length: 4, Precision: 24	
NumStories	Number of stories in the building	Yes	Tinyint, Length: 1, Precision: 3	Hazus will assume 1 if not populated. See Table 10-2 for acceptable values.
DesignLevel	Design level of structure based on year built	No	Text, Length: 1	See Table 10-3 for acceptable values.
FoundationType	Foundation type of the structure	Yes	Text, Length: 1	Hazus will assume 7 (slab on grade) if not populated. See Table 10-4 for acceptable values. Used to determine with or without basement for RES1 occupancies.
FirstFloorHt	First floor height above grade	No	Float, Length: 8, Precision: 53	Value should be locally derived. Hazus will assume 0 if not populated. See Table 10-4 for acceptable values.

Attribute	Description	Minimum Requirement	Field Type	Comments
ContentCost	Contents replacement cost	No	Money, Length: 8, Precision: 19, Scale: 4	If not populated, Hazus will assume default value based on Cost and standard Hazus default contents value multiplier assumptions. See Hazus technical manuals or Hazus Analysis menu for specific multipliers.
BldgDamageFnId	Building Damage Function ID	No	Text, Length: 10	If not populated, Hazus will assume default value based on Occupancy, Number of stories, and Foundation Type. See Hazus technical manuals or Hazus Analysis menu for specific values.
ContDamageFnId	Contents Damage Function ID	No	Text, Length: 10	If not populated, Hazus will assume default value based on Occupancy, Number of stories, and Foundation Type. See Hazus technical manuals or Hazus Analysis menu for specific values.
InvdamageFnId	Inventory Damage Function ID	No	Text, Length: 10	If not populated, Hazus will assume default value based on Occupancy, Number of stories, and Foundation Type. See Hazus technical manuals or Hazus Analysis menu for specific values.
FloodProtection	Level of protection provided by a dam or levee in whole feet	No	Int, Length: 4 Precision: 10	Hazus will assume 0 if not populated. If near dam or levee, set value for level of protection in whole feet.
ShelterCapacity	Capacity, in number of people, for structure providing shelter	No	Smallint, Length: 2 Precision: 5	Not used in Hazus.
BUPower	Is backup power available?	No	Bit, Length: 1	No (default) = 0, Yes = 1. Not used in Hazus.
Latitude/Longitude	The location of the structure	Yes	Decimal, Length: 9, Precision: 11, Scale: 6	Imported data will pull location from spatial attributes of each structure point; manually entered data with Hazus user interface will require entering values when adding a UDF point.
Comment	Open text field	No	Text, Length: 40	Text field for additional information.

Table 10-2: NumStories Field Description

Occupancy	Number of Stories from Parcel Data	NumStories Value
RES1	1	1
RES1	2	2
RES1	3	3
RES1	Split-Level	4
RES2	1	1
RES2	2	2
RES2	3	3
RES3	1–2	1
RES3	3–4	3
RES3	5+	5
All other occupancies	1–3	1
All other occupancies	4–7	4
All other occupancies	8+	8

Table 10-3: DesignLevel Field Description

Year Built	Design Level Value
Prior – 1950	1
1950 – 1970	2
Post 1970	3
0 (set to Null)	0

Table 10-4: FoundationType Field and FirstFloorHt Field Description

Foundation Type from Parcel Data	FoundationType Value	Default FirstFloorHt (feet) Value
Pile	1	7
Pier	2	5
Solid Wall	3	7
Basement/Yard	4	4
Crawl Space	5	3
Fill	6	2
Slab on Grade	7	1

These values are based on Pre-FIRM construction for Riverine, Great Lakes, and Coastal Construction census blocks as defined through the Flood Specific Occupancy Mapping table.

10.2 UDF User-Supplied Inventory

The creation of user-supplied inventory can require varying levels work to prepare. The extent of preparation and data compilation work involved depends on the condition and completeness of existing information, required data conversions, and the contributions of subject expertise. The greatest impact from enhanced inputs are produced by editing both the default inventory.

The most detailed type of analysis incorporates the results from completed loss studies. For example, the output of loss estimates performed using locally developed traffic models that have identified the bridges most susceptible to damage can be included. Similar analyses can provide information on water distribution or other pipeline systems. Updates to the vulnerability ratings for each model building type will also produce more accurate analysis results.

Running a baseline analysis for comparison with results after introduction of user-supplied data is recommended. Sensitivity of the loss estimation methodology under local conditions is measured best by review of outputs after inclusion of each enhanced inventory. Good record-keeping and inventory of documentation are essential.

In some cases, data collected will have to be adjusted so that the inventory is classified according to the systems defined in the methodology. For example, a school may have two building wing additions that were constructed over the 40-year lifetime of the structure. Each era of construction used improved materials, but the best materials were used to construct the smallest addition. The individual responsible for assigning the building type of the school according to the Hazus methodology will need to define and document the criteria applied to classify the structure. The easiest approach is to break the facility into different entries (i.e., records).

Consult the *Hazus Comprehensive Data Management System User Guidance* for specific information on use of that tool for data editing and entry.

11 Advanced Hazus Analysis: Hurricane Surge Scenario

The Hazus tool can run a combined hurricane and flood hazard analysis for coastal areas. In order to run a combined hurricane and flood hazard, a multi-hazard (flood and hurricane) Study Region that includes a shoreline must be built. To build the Study Region, follow the workflow shown in Table 11-1. The inputs will be used to determine the extent of flooding due to a wind-driven storm and estimate the flood losses associated with the hurricane.

Table 11-1: Workflow to Build Multi-Hazard Study Region

Model	Inputs
Hurricane	• Define/Select Hurricane Scenario • Run Analysis with Surge-Only or Surge and Waves • Display Wind-Only Losses
Flood	• Select Coastal Surge • Define Topography • Define Scenario • Delineate Floodplain • Run Flood-Only Analysis • Run Combined Loss Analysis
Hurricane or Flood	• Display Combined Losses

11.1 Storm Surge Scenario Options

The storm surge scenario options are available for four hurricane scenario types:

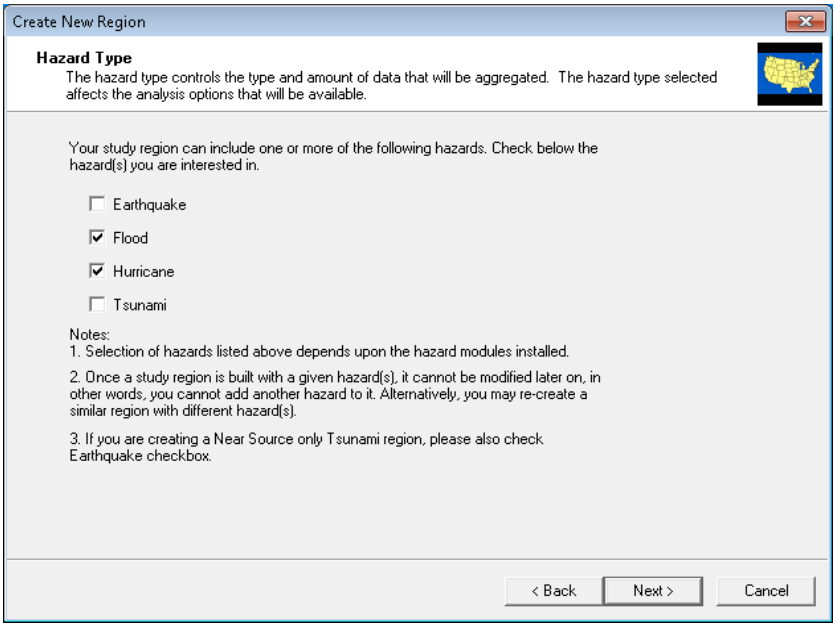
- User defined
- Hazus import
- Historic
- Hurrevac (hurricane evacuation tool) import (less than 24 hours before landfall); also see Section 6.3.3

The storm surge scenario options are not available for:

- Hurricane surface wind file (.dat file format)
- Probabilistic

To run a coastal surge analysis, the Study Region must have been created for both Hurricane and Flood Hazard analysis. As shown in Chapter 3, start with create a New Region Wizard (Figure 11-1). Check both **Flood** and **Hurricane** hazard boxes and click **Next**.

Figure 11-1: Select Hazards for New Region

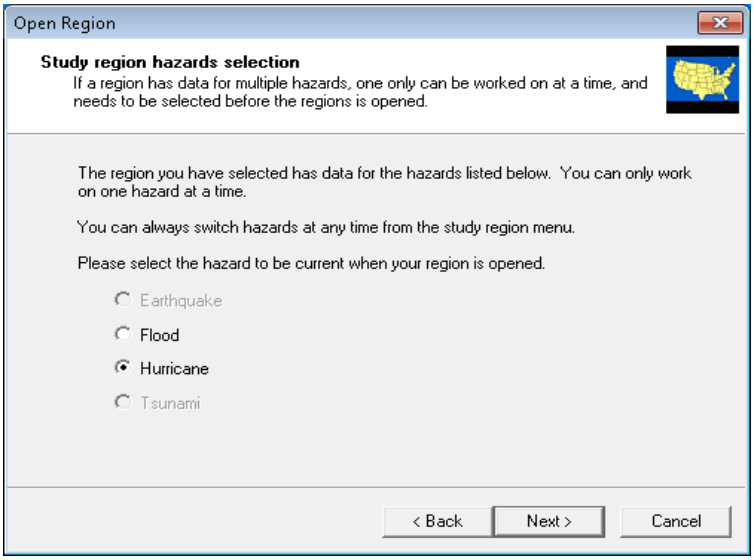


Specify the Study Region and finish the Create New Region wizard.

NOTE: Limiting coastal surge Study Regions to a single county is recommended. In some cases, a single county may need to be split into two regions.

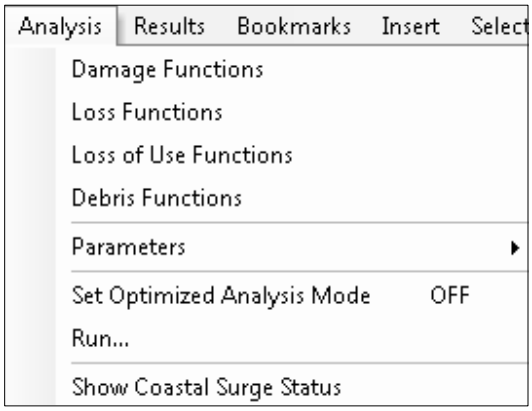
Open a region and select the new multi-hazard. When prompted, select the Hurricane Model to open first, as shown in Figure 11-2. Click **Next** and then click **Finish** to open the region.

Figure 11-2: Select Hurricane Model First in Study Region



Analysis / Set Optimized Analysis Mode must be “Off,” as shown in Figure 11-3.

Figure 11-3: Ensure Optimized Analysis Mode is Off



Check **Hazard / Show Current** to make sure the scenario is set to manual, Hazus import, historical, or Hurrevac import (Figure 11-4). If the scenario needs to be changed, use **Hazard / Scenario** to open the Scenario Management Wizard discussed previously (Figure 11-5).

Figure 11-4: Review Scenario in Hazard / Show Current

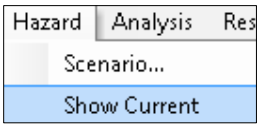
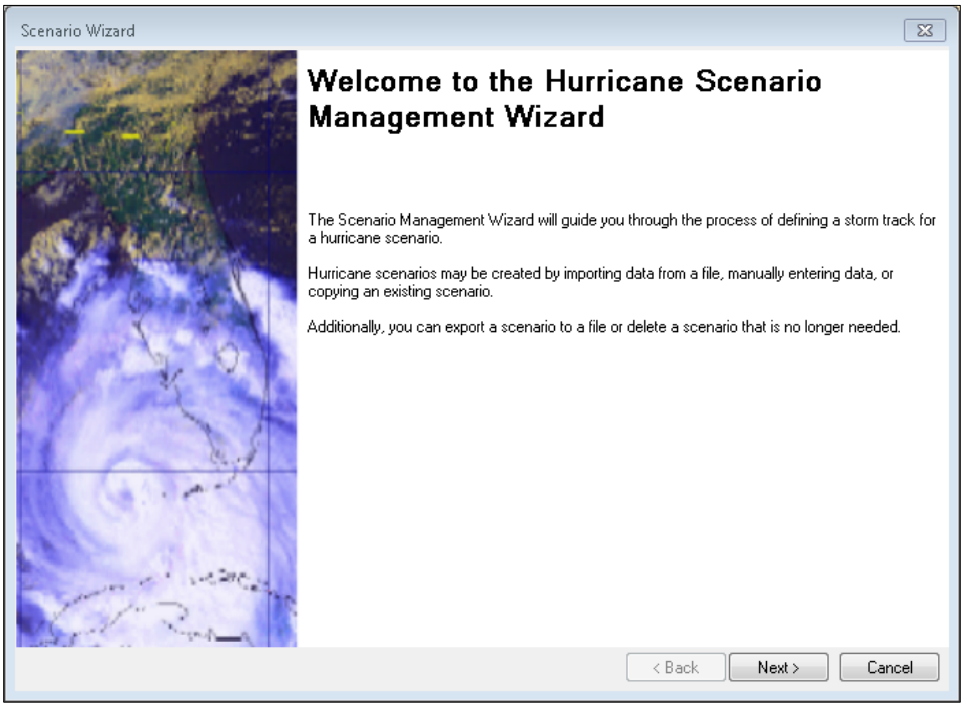


Figure 11-5: Scenario Management Wizard



11.2 Run Storm Surge Analysis

Open the **Analysis Options** from the **Analysis / Run** menu (Figure 11-6). When storm surge is selected, as shown in Figure 11-7, a storm surge analysis using the National Oceanic and Atmospheric Administration (NOAA) Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model is executed in the Hurricane Model to produce estimates of coastal still water elevations. Note that the storm track that is used should extend beyond the outer boundary of the applicable SLOSH basin grids.

Figure 11-6: Analysis Run Storm Surge Menu

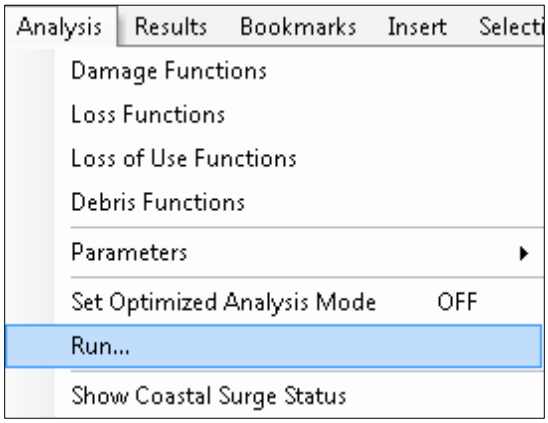
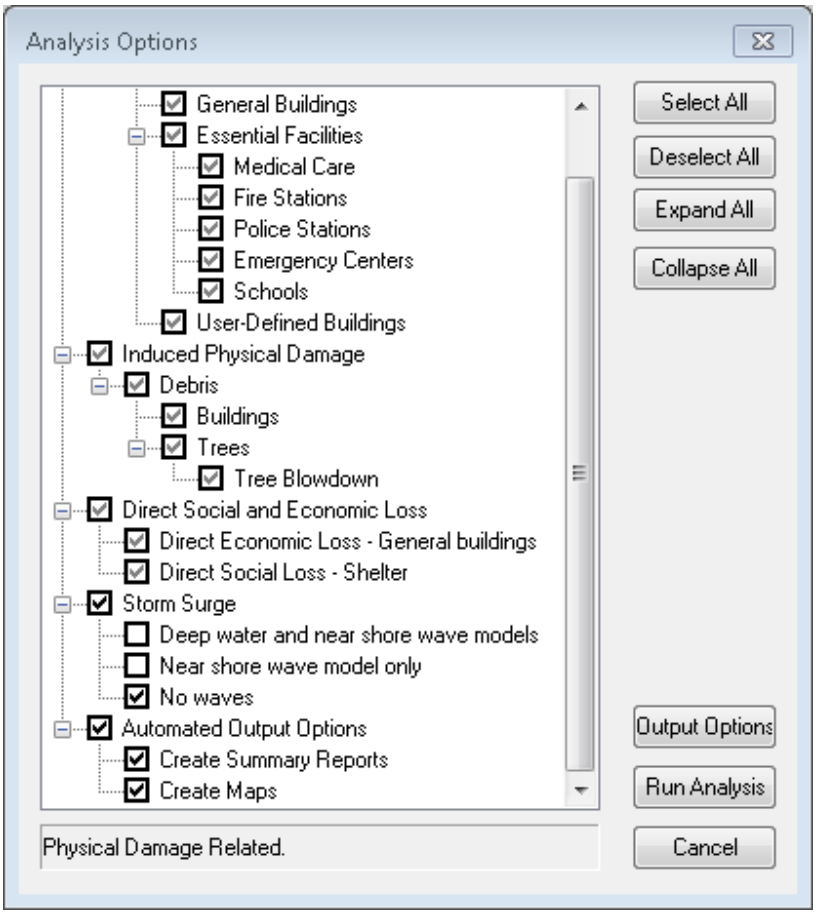


Figure 11-7: Analysis Options for Storm Surge



In addition, there are options for running coupled surge and wave analysis using the Delft University Simulating WAves Nearshore (SWAN) model if checked (refer to the Technical Manual for more details on the modeling approaches used for SWAN and SLOSH):

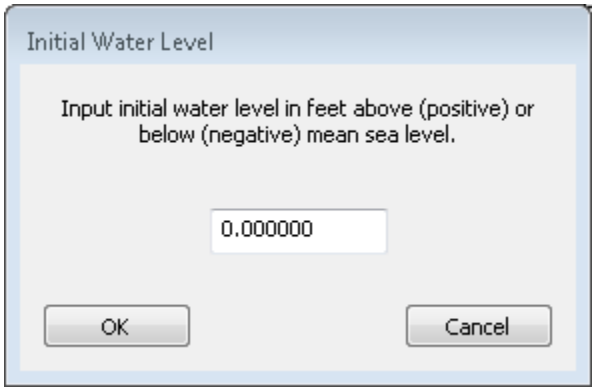
- **Deep water and near shore wave models**. A coarse analysis of the entire northwest Atlantic basin is run, and the results are then coupled into one or more nearshore wave grids, which are superimposed on the relevant SLOSH basin(s). This option is the most detailed and slowest running. The storm track used should also extend all the way out to 60 degrees west longitude when this option is selected.
- **Near shore wave model only**. This option runs a coupled surge and wave analysis within the relevant SLOSH basin(s) only. This option is faster than the first option but still significantly slower running than the “no waves” option.
- **No waves**. This option skips the SWAN model entirely. For this case, the Flood Model assumes depth-limited waves at the coastline rather than using significant wave heights produced by SWAN. This is the fastest option.

When appropriate boxes have been checked in the Analysis Options, click **Run Analysis**.

At the start of the analysis, the Hurricane Model prompts the user for an **initial water level** in feet with respect to the North American Vertical Datum (NAVD) 1988 datum shown in

Figure 11-8. This represents the water level along the coast that would have been expected (in the absence of the hurricane) near the center of the Study Region at the time of hurricane landfall. The initial water level can be estimated by using NOAA tide forecasts plus the pre-storm tidal anomaly (i.e., the difference between the forecast and observed water level 2 days before landfall).

Figure 11-8: Provide Initial Water Level



When running a coastal surge hazard analysis (Figure 11-9) in the Hurricane Model, a second progress dialog will appear after the wind-only damage and loss calculations are completed (Figure 11-10).

Figure 11-9: Run Analysis Progress Status Window

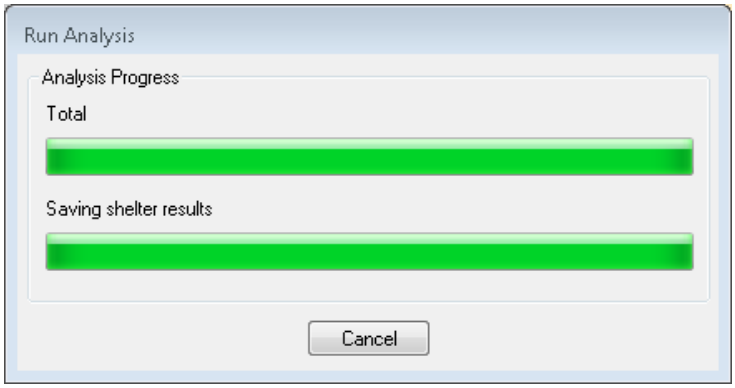
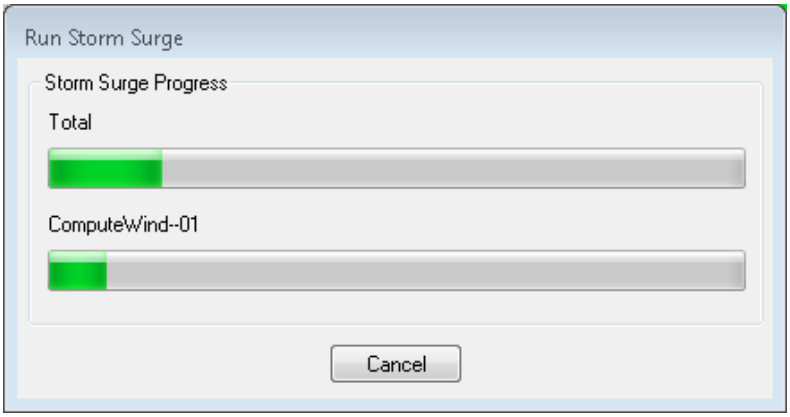
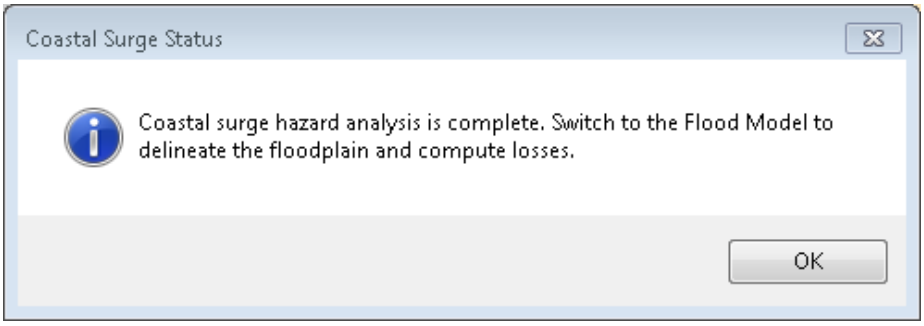


Figure 11-10: Run Storm Surge Progress Status Window



When a hurricane coastal storm surge analysis is run, two sets of direct building losses are produced: one set for the wind damage by itself and a second set for the combined wind and surge damage. When the coastal surge analysis is complete, click the **Analysis / Show Coastal Surge Status** to confirm that the analysis was successful, as shown by the status box in Figure 11-11.

Figure 11-11: Coastal Surge Status Window



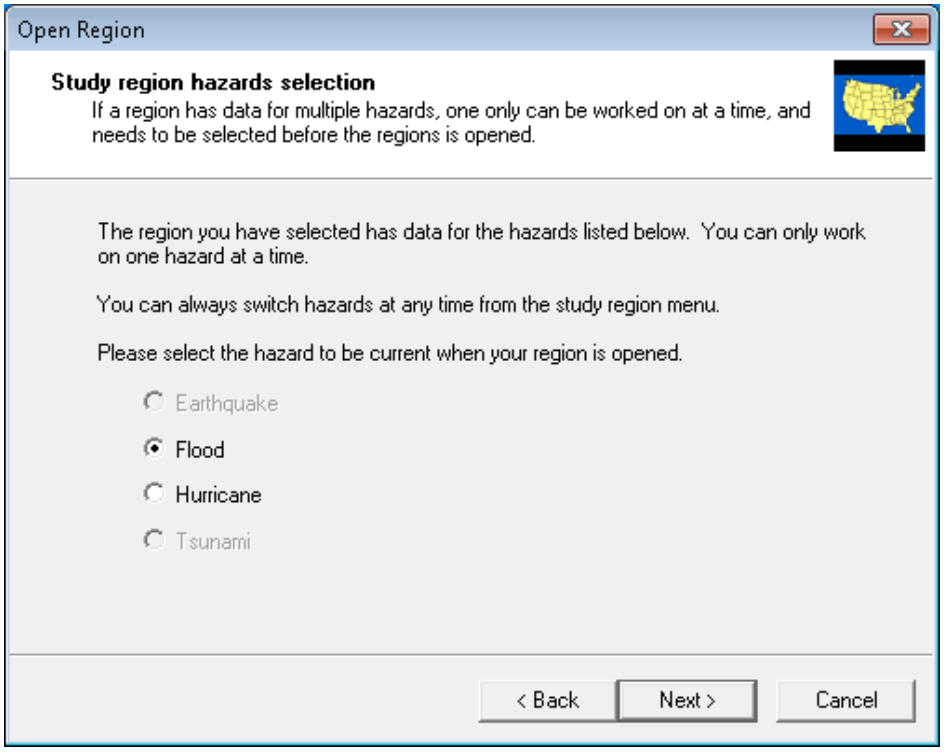
To obtain the combined wind and surge losses, users must run a Coastal Surge analysis and calculate the combined losses in the Flood Model. See further instructions in the Hazus Flood Model Manual.

11.3 Storm Surge

After the Hurricane Model has been run, reopen the Study Region in the Flood Model.

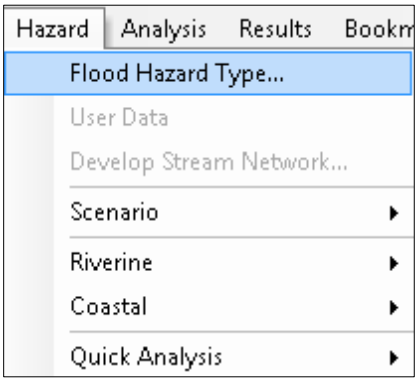
View as **Flood**, shown in Figure 11-12. Click **Next** and then click **Finish** to open region.

Figure 11-12: Select Flood Model in Study Region



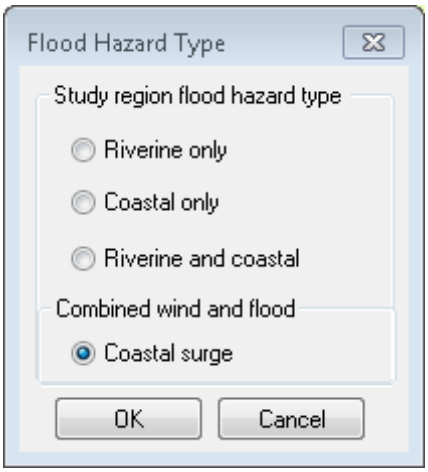
Open the **Hazard** menu and select **Flood Hazard Type** (Figure 11-13).

Figure 11-13: Select Flood Hazard Type



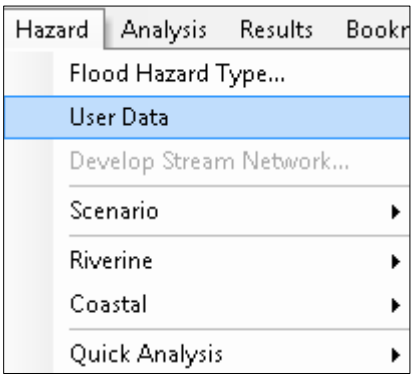
Select the **Flood Hazard** type **Coastal Surge** and click **OK** (Figure 11-14).

Figure 11-14: Select Coastal Surge



After the hazard type is set, the user must import a DEM for the Study Region by opening the **Hazard** menu and selecting the **User Data** dialog (Figure 11-15).

Figure 11-15: Select User Data to Import DEM



The **User Data** dialog will only contain two tabs, **DEM** and **Coastal Surge**. Use the **Browse** button to add the DEM to the Model (Figure 11-16). Figure 11-17 shows the **Coastal Surge** tab, where the Surge Elevation Grid (SLOSH) and Significant Wave Height Grid (SWAN) that were produced by the Hurricane Model are in the Study Region folder as surge.flt, surge.hdr (SLOSH), and waveht.flt, waveht.hdr (SWAN). When the DEM is uploaded, click **OK**. See the Hazus Flood Model Manual for more details about obtaining DEM data.

Figure 11-16: Add User Data DEM to Model

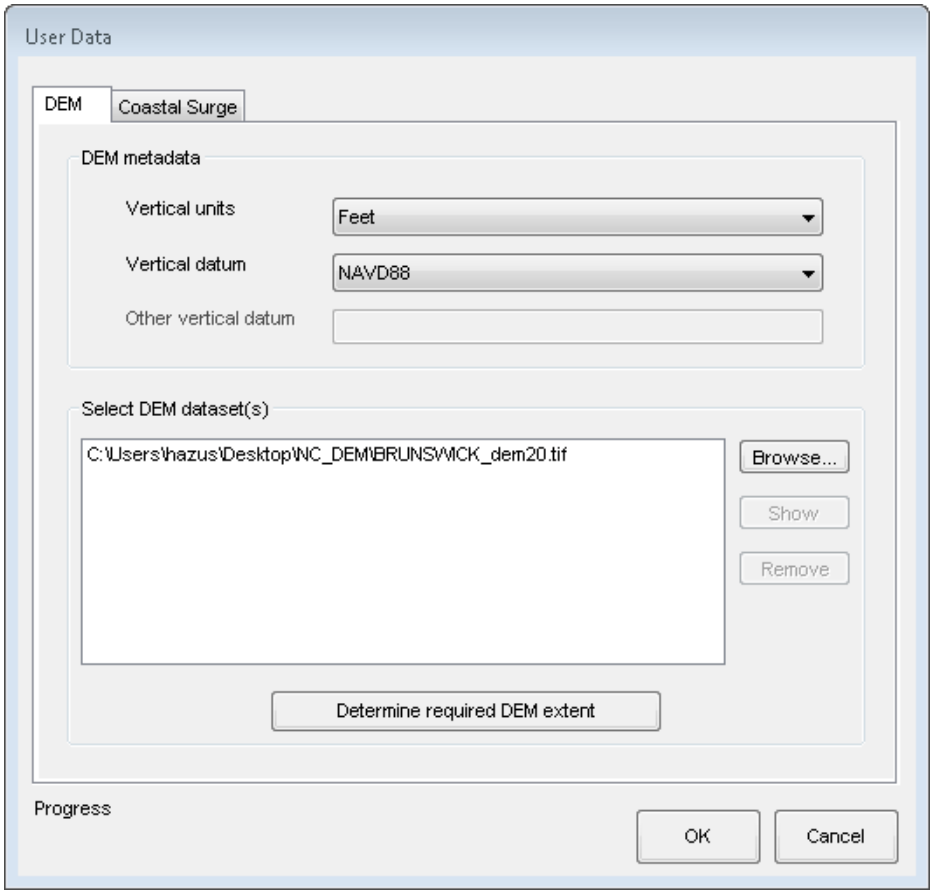
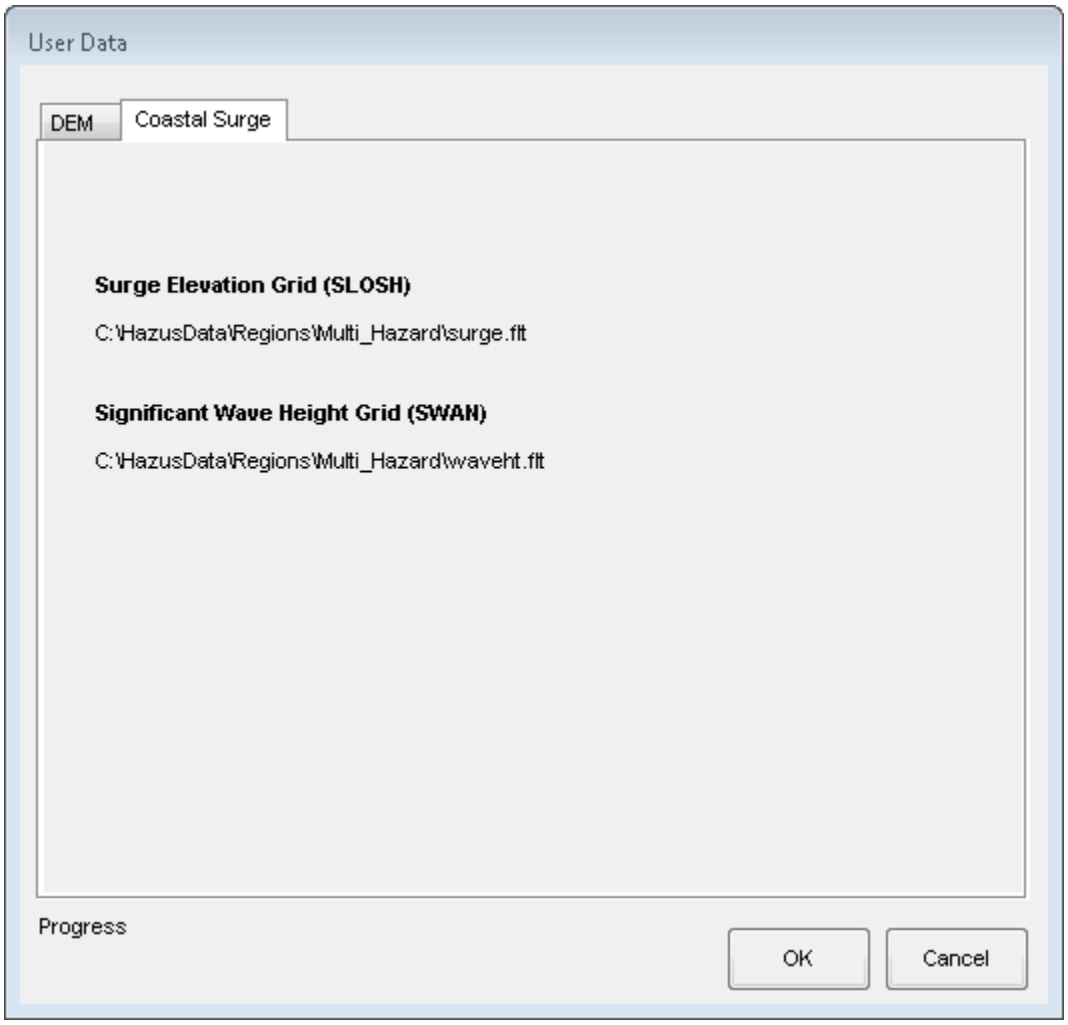


Figure 11-17: Review User Data in Coastal Surge Tab



When the DEM uploads successfully, the user needs to create a new scenario next, using **Hazard / Scenario / New** (Figure 11-18). Enter a unique name for the scenario and click **OK** (Figure 11-19). In the coastal surge scenarios, the surge and wave height files are automatically selected, and users do not need to select or save any features because the Hurricane Model supports only one scenario per Study Region.

Figure 11-18: Select New Scenario in Hazard Menu

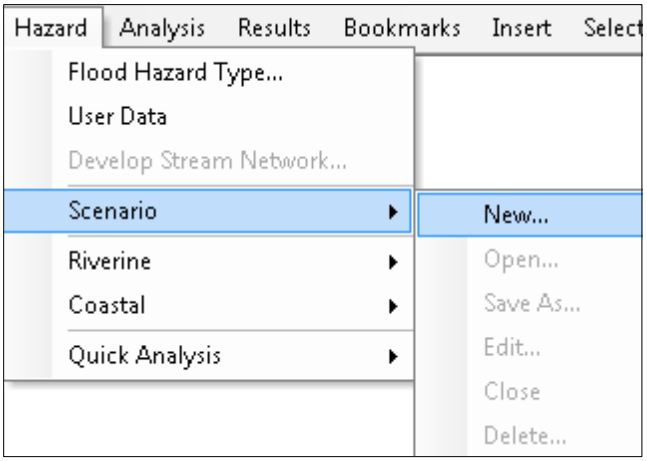
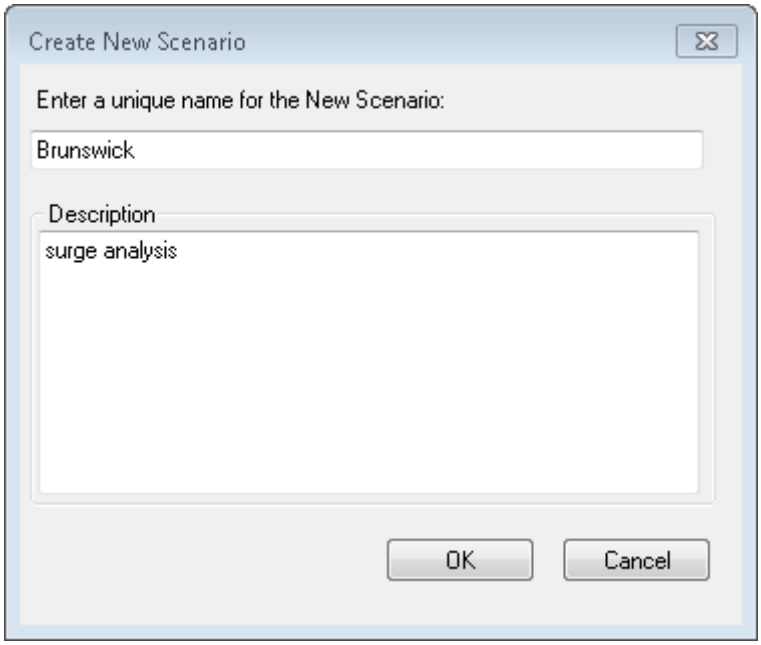
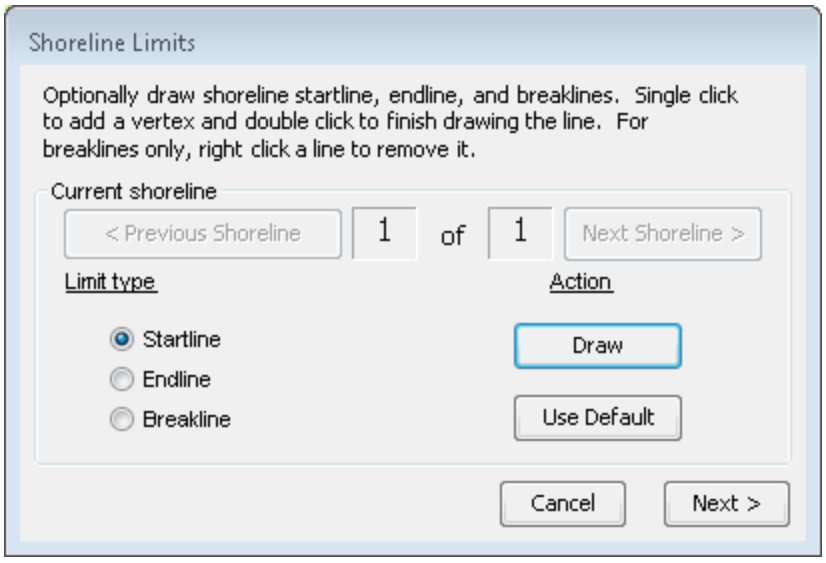


Figure 11-19: Provide Name for New Scenario



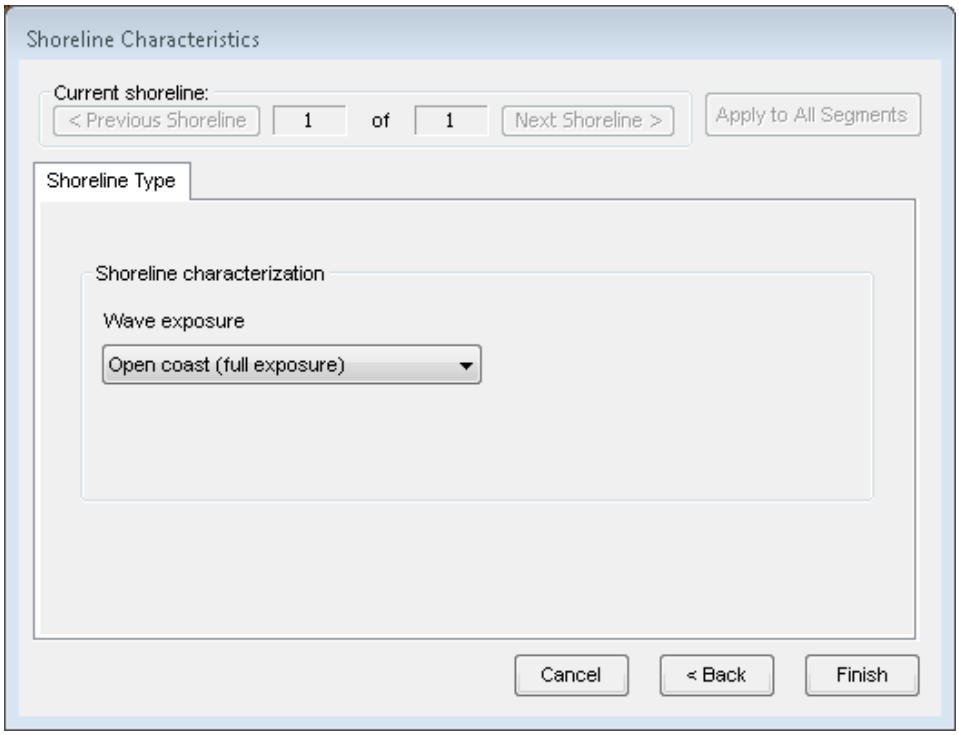
If the user selected **No Waves** in the Storm Surge analysis for the Hurricane Model, only the surge elevation grid was created for the Study Region. The wave height grid (waveht.flt) was not produced and the shoreline needs to be characterized. In this case, after creating a new scenario, the shoreline limits dialog will pop up, as shown in Figure 11-20.

Figure 11-20: Input Shoreline Limits



After clicking **Next**, there will be an additional shoreline characterization dialog, as shown in Figure 11-21. The **Shoreline Type** tab has one required input (wave exposure).

Figure 11-21: Select Shoreline Characteristics



The options for the wave exposure include:

- **Open coast (full exposure)**: Any shoreline where the storm surge and waves come directly off open waters without the benefit of barrier islands or other land mass protection. Think in terms of lines of waves marching directly onto the shoreline uninterrupted. Full exposure is the Hazus default.
- **Moderate exposure**: Best represented by a shoreline that is slightly protected from the storm surge and associated waves. Moderate exposure might be a shoreline that has small islands or a low-lying sandbar that help break the direct force of the waves on the shoreline. A shoreline with moderate exposure might be angled to the direct line of the waves and will therefore receive a portion of the wave front.
- **Minimal exposure**: Best represented by a shoreline that is not in direct line with the storm surge or the waves. Minimal exposure might include an exposed shoreline that is running close to parallel to the storm surge and is therefore not bearing the brunt of the wave fronts.
- **Sheltered**: Best represented by the shoreline within a bay or protected by a larger barrier island. Sheltered could also be a shoreline along a large river inlet. The shoreline is sheltered from the wave front and is most likely subjected to stillwater flooding.

The default parameter is **Open coast (full exposure)**. At the top of the screen, the user can switch from one shoreline segment (if more than one) to another and back. If there are multiple segments and most have a single characteristic and a few have unique characteristics, the user can save time and effort by applying the common characteristic to all segments by pressing **Apply to All Segments** and then editing the unique segments.

After selections, click **Finish**.

Proceed to **Delineate Floodplain** by going to the **Hazard** Menu and selecting **Coastal** (Figure 11-22). When it is finished, the completion window will be shown as in Figure 11-23.

Figure 11-22: Select Coastal to Delineate Floodplain

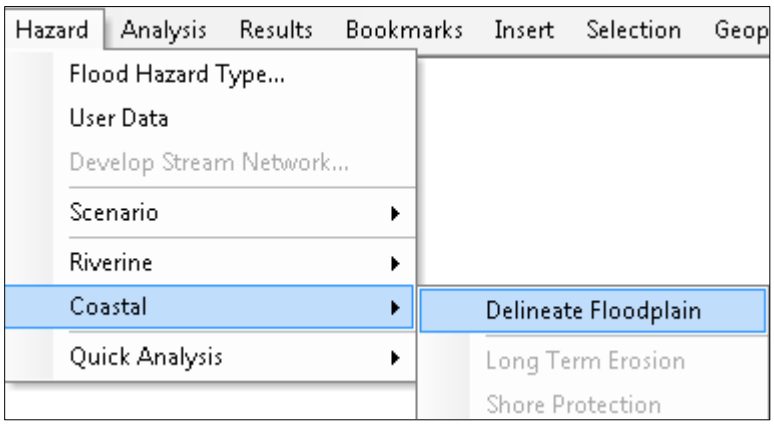


Figure 11-23: Delineate Floodplain Completion Status Window

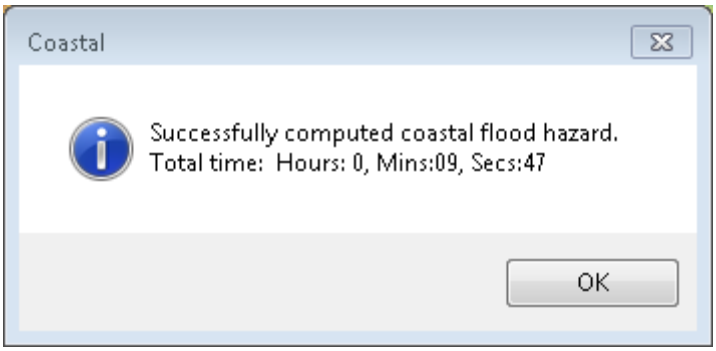
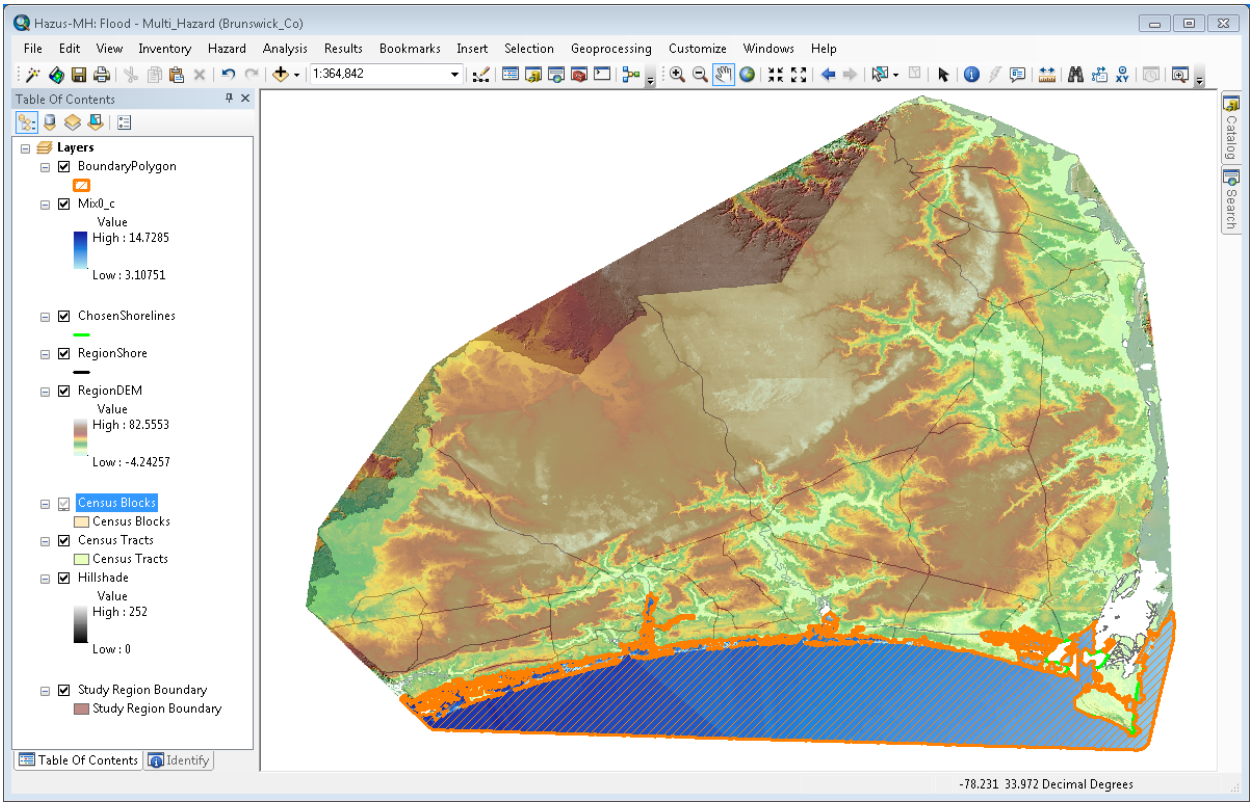


Figure 11-24 displays the completed hazard portion of a coastal surge model. The coastal surge model outputs a flood depth grid named “Mix0_c” to the map, which comprises SLOSH and wave height grids.

Figure 11-24: Example – Coastal Surge Floodplain Delineation



The next step to complete the analysis is by using the **Analysis** Menu and choose **Run** (Figure 11-25). Next, check the **General Building Stock Damage and Loss** option and click **OK (**Figure 11-26**)**.

Figure 11-25: Select Run in Analysis Menu

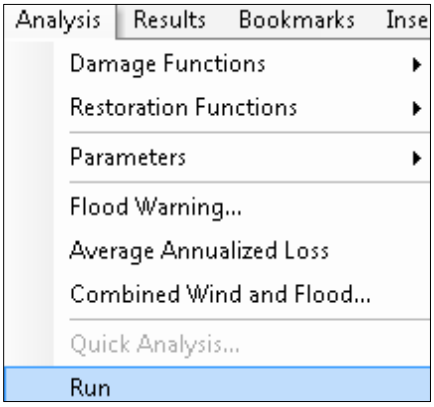
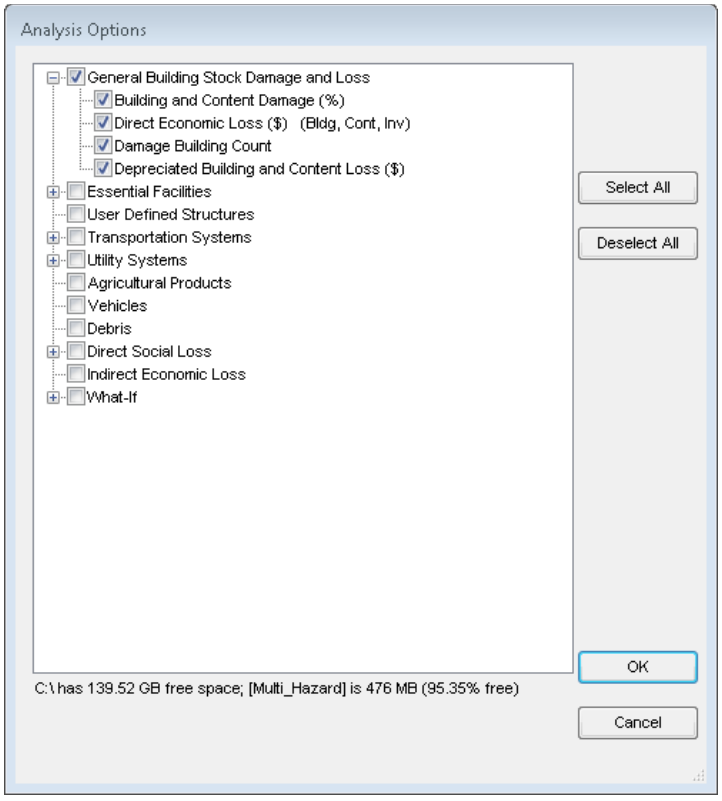


Figure 11-26: Select Preferred Analysis Options



The final step of a storm surge analysis is to calculate the combined hurricane wind and coastal storm surge losses, using the **Analysis** Menu and selecting **Combined Wind and Flood…** (Figure 11-27). When the combined losses are completed, click **OK** to the message box (Figure 11-28).

Figure 11-27: Select Combined Wind and Flood to Calculate Losses

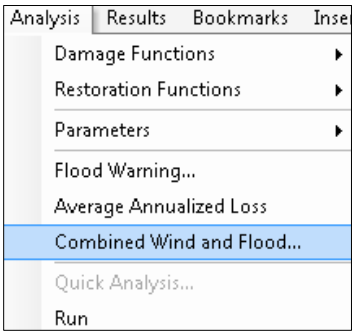
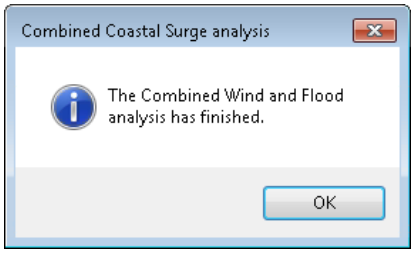


Figure 11-28: Combined Coastal Surge Status Window



When the analysis options have finished running, use the **Results Menu** (Figure 11-29) to **View Current Scenario Results By…**, select the scenario in the dropdown, and click **OK,** as shown in Figure 11-30.

Figure 11-29: Select View Current Scenario Results

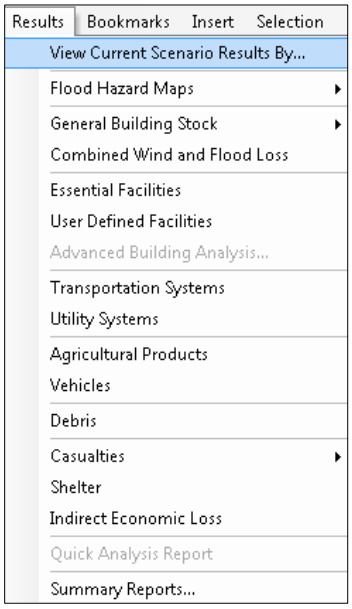
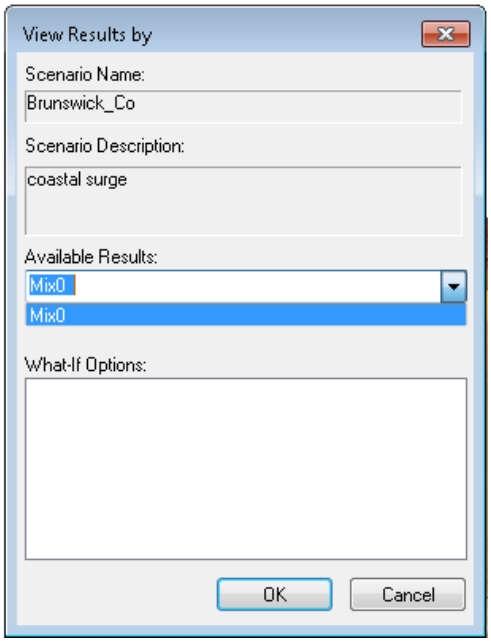


Figure 11-30: Select Available Results for Surge Analysis



The combined losses can be viewed either in the Flood Model or in the Hurricane Model using either the **Results** / **Combined Wind and Surge Loss** menu (Figure 11-31 and Figure 11-32) or the **Results** / **Summary Reports** / **Direct Losses** – **Combined Wind and Surge Loss** summary report. An example results table is shown in Figure 11-33.

Figure 11-31: Select Combined Wind and Flood Loss Results (Flood Model)

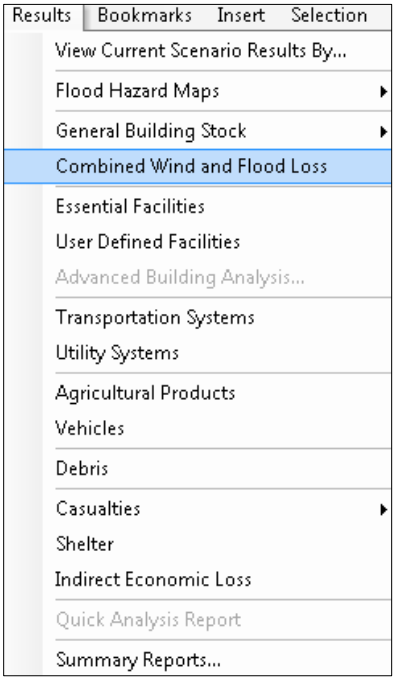


Figure 11-32: Select Combined Wind and Surge Loss (Hurricane Model)

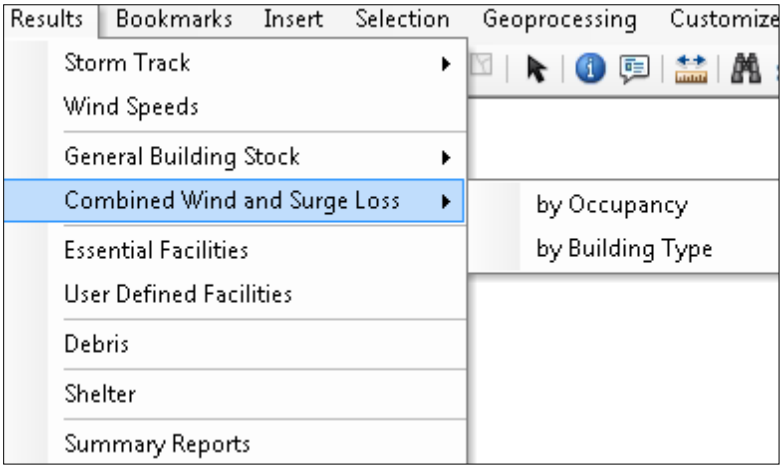
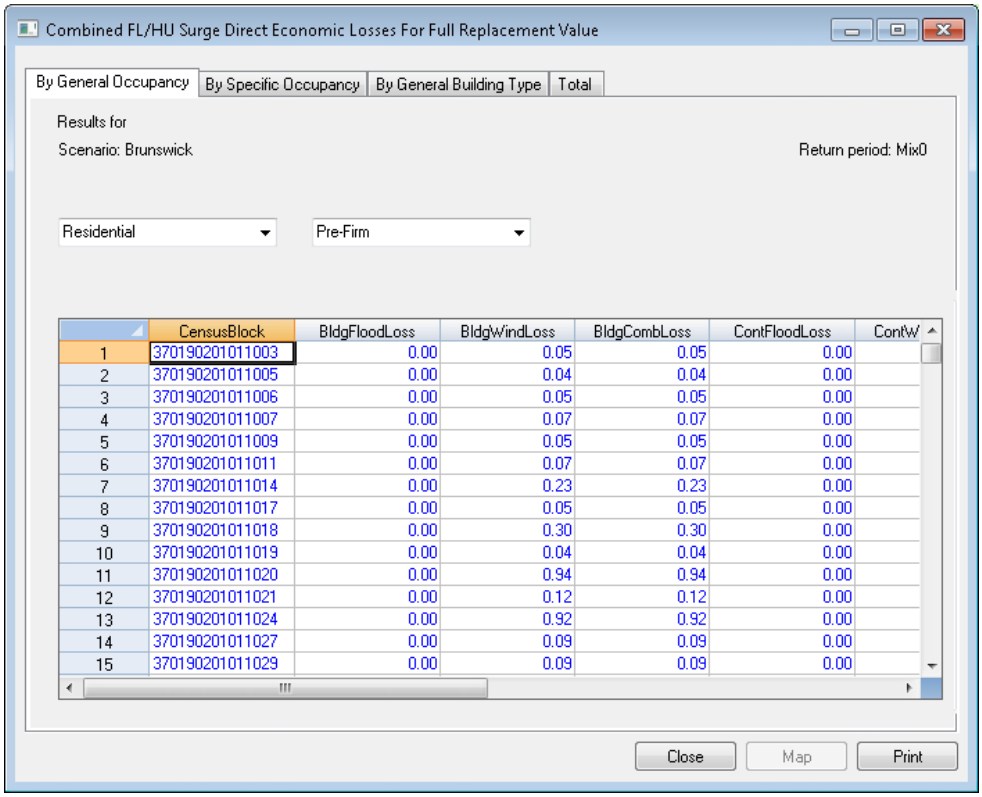


Figure 11-33: Example – Combined Surge Result Table



	CensusBlock	BldgFloodLoss	BldgWindLoss	BldgCombLoss	ContFloodLoss	ContW
1	370190201011003	0.00	0.05	0.05	0.00	
2	370190201011005	0.00	0.04	0.04	0.00	
3	370190201011006	0.00	0.05	0.05	0.00	
4	370190201011007	0.00	0.07	0.07	0.00	
5	370190201011009	0.00	0.05	0.05	0.00	
6	370190201011011	0.00	0.07	0.07	0.00	
7	370190201011014	0.00	0.23	0.23	0.00	
8	370190201011017	0.00	0.05	0.05	0.00	
9	370190201011018	0.00	0.30	0.30	0.00	
10	370190201011019	0.00	0.04	0.04	0.00	
11	370190201011020	0.00	0.94	0.94	0.00	
12	370190201011021	0.00	0.12	0.12	0.00	
13	370190201011024	0.00	0.92	0.92	0.00	
14	370190201011027	0.00	0.09	0.09	0.00	
15	370190201011029	0.00	0.09	0.09	0.00	

Note that combined wind and surge results are available for building, content, and inventory losses but not for relocation, income, rental, or wage losses. The radio buttons and dropdown boxes allow the user to filter the losses by occupancy or building type.

Hazus has a limit of one scenario for the Coastal Surge flood hazard type. If the user already completed the coastal surge model in a Study Region and decides to re-run the Hurricane Model, the user must delete the previous flood scenario and re-input the DEM in the **User Data** dialog in the Flood Model.

12 Advanced Hazus Analysis: Import User-Defined Data

Users have the option to bypass processing the DEM if they plan to run a scenario that only includes the Flood Information Tool (FIT) projects, flood depth grids, and/or USACE Hydrologic Engineering Center's River Analysis System (HEC-RAS) .FLT grids. The Hazus Program recommends users import their specific flood hazard information from external sources via depth grids, HEC-RAS, or other hydrologic and hydraulic model.

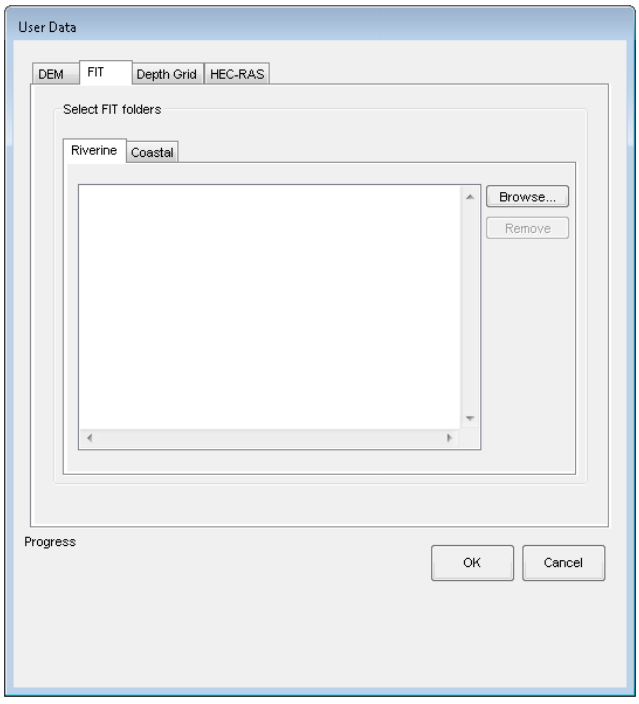
12.1 Import FIT Results

The FIT is an ArcGIS extension separate from Hazus that can be used to create flood hazard data for import to Hazus. The data are prepared outside of Hazus and then imported into the model. For more information regarding FIT, see the *Flood Information Tool User Manual*.

To import FIT data, select **User Data** from the **Hazard** menu. In the **User Data** window, select the **FIT** tab, as shown in Figure 12-1. Depending on the flood hazard type selected earlier, a **Riverine** and/or **Coastal** tab will be available.

Use the **Browse…** button to navigate to the location of the FIT working directory. The browse dialog is intended to select a folder, not the contents of it, so click on the working directory (do not double-click). Import the FIT working directory into the correct hazard tab. Repeat the process to import additional FIT working directories.

Figure 12-1: Select FIT Tab to Import FIT Data



12.2 Import Flood Depth Grid Results (preferred method for importing flood hazard information)

To import flood depth grid results into Hazus, select **User Data** from the **Hazard** menu. In the **User Data** window, select the **Depth Grid** tab, as shown in Figure 12-2. The format of user supplied depth grids can be Esri GRID, IMAGINE (.IMG), HEC-RAS (.FLT), tagged image file (.TIF), and file geodatabase (fGDB).

Use the **Browse…** button to navigate to the location of the flood depth grid. The browse dialog is intended to select a raster. After importing the flood depth grid, select the newly imported flood depth grid and click the **Set Parameters** button. A **Set Parameters** window will appear (Figure 12-3). Use the drop-down menu to select the **Units** (feet or meters), and then input the **Return Period** of the flood depth grid. It is important that users import the flood depth grid into the correct hazard tab. Repeat the process to import additional flood depth grids.

Figure 12-2: Select Depth Grid Tab to Import Depth Grid Data

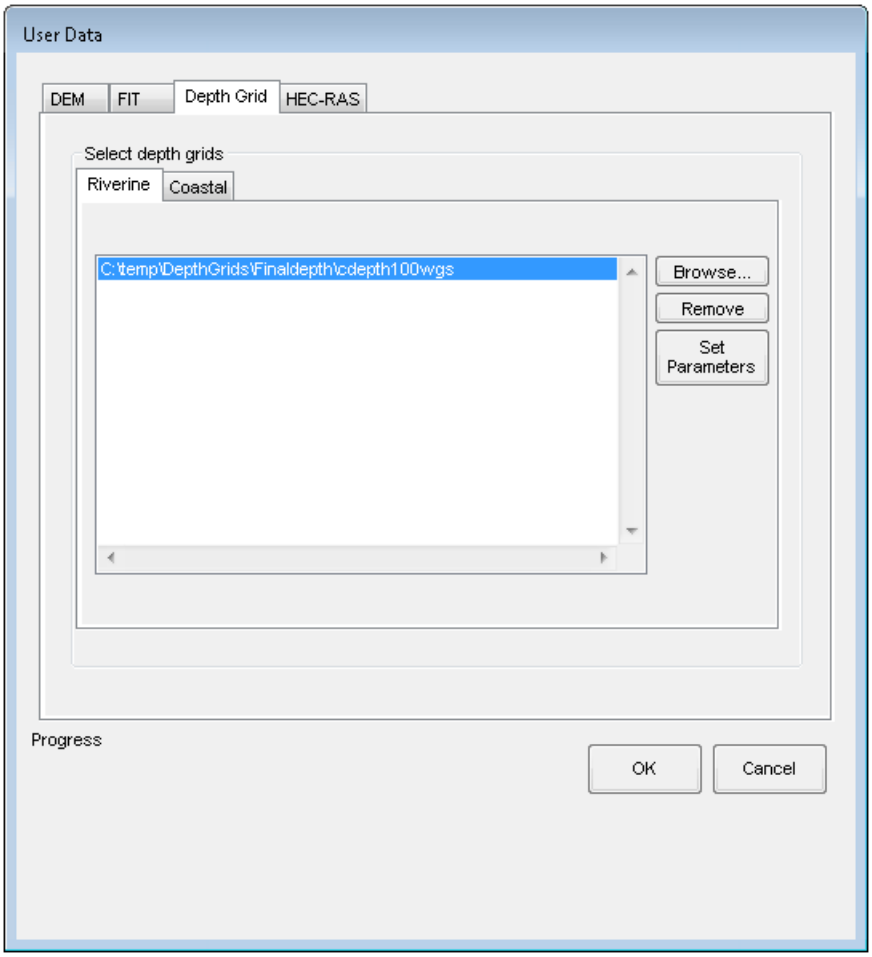
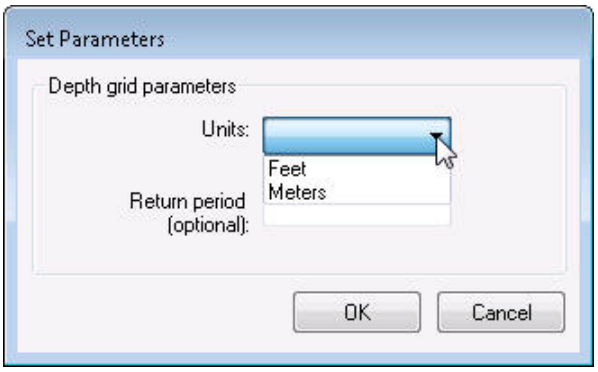


Figure 12-3: Set Parameters for Depth Grid Dialog



12.3 Import HEC-RAS .FLT Grid Results (preferred method for importing flood hazard information)

Users of HEC-RAS can import HEC-RAS (via RAS Mapper) hydraulic output .FLT grids to be used in the Flood Model. The HEC-RAS .FLT grids are implicitly treated as Riverine. To import HEC-RAS .FLT grid results into Hazus, select **User Data** from the **Hazard** menu. In the **User Data** window, select the **HEC-RAS** tab, as shown in Figure 12-4.

Use the **Browse** button to navigate to the HEC-RAS (produced via RAS Mapper) hydraulic output .FLT grid. The browse dialog is intended to select a floating-point binary file. After the .FLT grid is selected, the Flood Model validates the input by making sure the .FLT grid's associated floodplain boundary (by default HEC-RAS saves it as FloodMap) is located partially within the Study Region (geographically) and contains projection information (prj.adf). The Flood Model does not validate the integrity between the .FLT grid and the floodplain boundary polygon (by default HEC-RAS saves it as FloodMap). A status bar, shown at the bottom of the window in Figure 12-4, will indicate the level of progress as the data is imported and validated.

Select the newly imported .FLT grid and click the **Set Parameters** button. A **Set Parameters** window will appear (Figure 12-5). Use the drop-down menu to select the **Units** (feet or meters), and then input the **Return Period** of the flood depth grid. Repeat the process to import additional HEC-RAS .FLT grids.

Figure 12-4: Select the HEC-RAS Tab to Import .FLT Grid Data

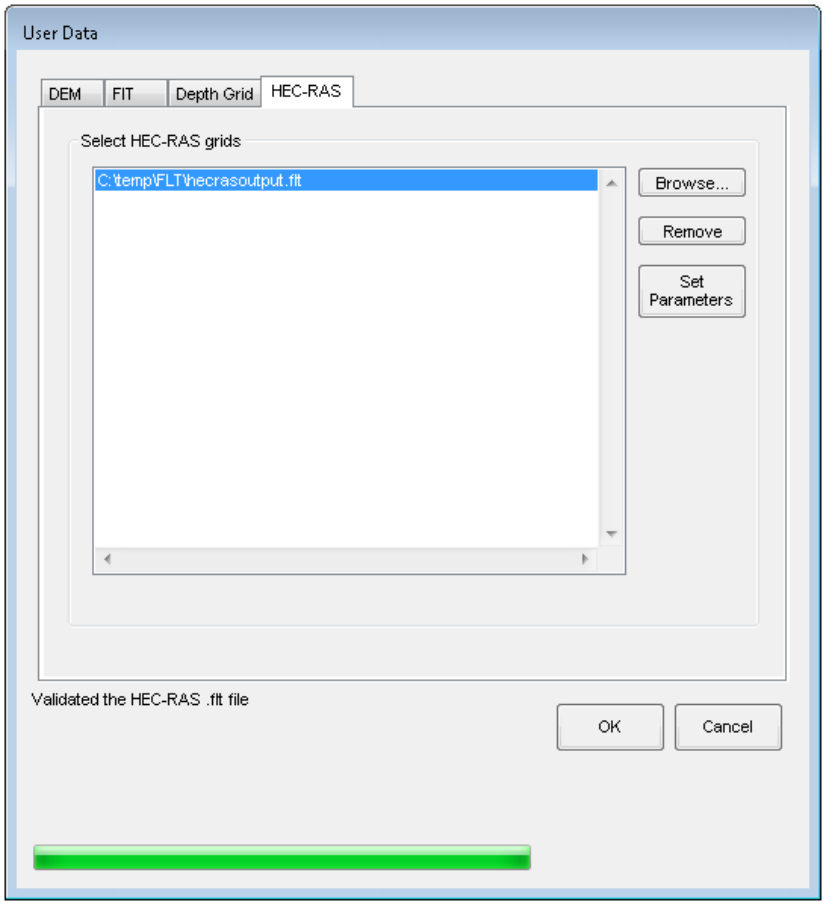
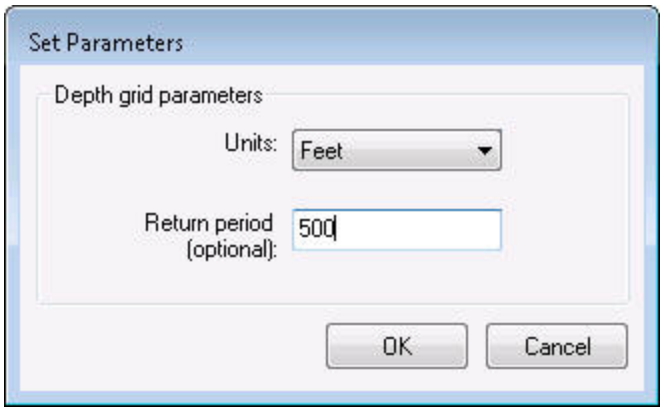


Figure 12-5: Set Parameters for .FLT Grid Dialog



13 Quick Look and Enhanced Quick Look

The **Quick Look** and **Enhanced Quick Look** analyses allow the user to quickly produce a rough estimate of flood damages, without working through the entire process of generating a stream network or delineating a floodplain either within Hazus or from external modeling tools. For the **Quick Look** analysis, the user delineates a polygon of equal flood depth that is used to conduct a "quick" analysis for GBS only. For the **Enhanced Quick Look** analysis, the user imports a polygon that represents the floodplain boundary and the DEM for the area of this boundary, and then Hazus estimates the flood depth for areas within the imported boundary. Like **Quick Look**, **Enhanced Quick Look** only calculates GBS losses.

This chapter includes step-by-step instructions on how to perform a Quick Look and Enhanced Quick Look analysis. These steps assume the user has already created and opened a Study Region as detailed in Chapter 3.

13.1 Select Flood Hazard Type

Launch Hazus and open the new Study Region created specifically for a **Quick Look** or **Enhanced Quick** analysis.

Select a **Flood Hazard Type** to perform either a **Quick Look** or **Enhanced Quick Look** analysis. For example, to perform a riverine analysis, open the **Hazard** menu and select **Flood Hazard Type** (Figure 13-1) to open the **Flood Hazard Type** window (Figure 13-2). Select **Riverine only**, and click **OK**. A similar approach would be used if the analysis were for coastal flooding, by selecting **Coastal only**.

Figure 13-1: Select Flood Hazard Type in Hazard Menu

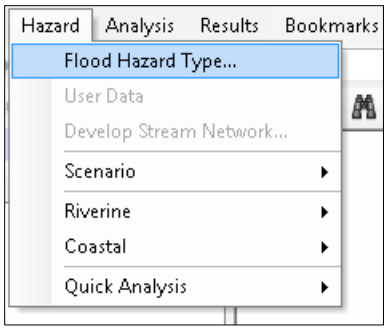
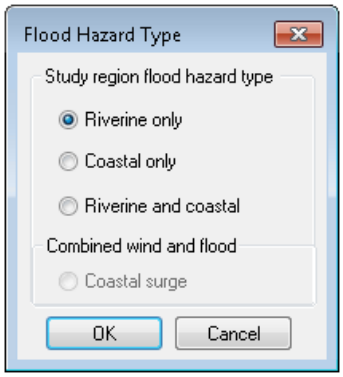


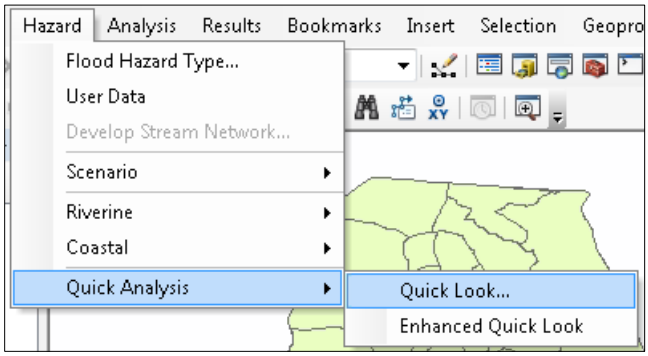
Figure 13-2: Select Flood Hazard Type



13.2 Perform Quick Analysis

After selecting the **Flood Hazard Type**, proceed directly to the Quick Analysis by opening the **Hazard** menu and selecting **Quick Analysis** (Figure 13-3). The user does not need to enter **User Data** nor define a **Scenario**, which are typically required for a flood analysis within Hazus.

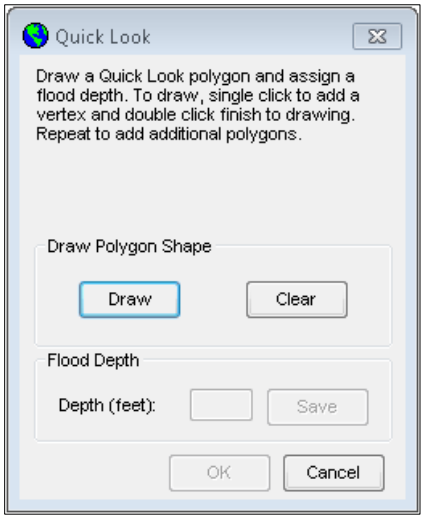
Figure 13-3: Quick Analysis Menu



13.2.1 Quick Look

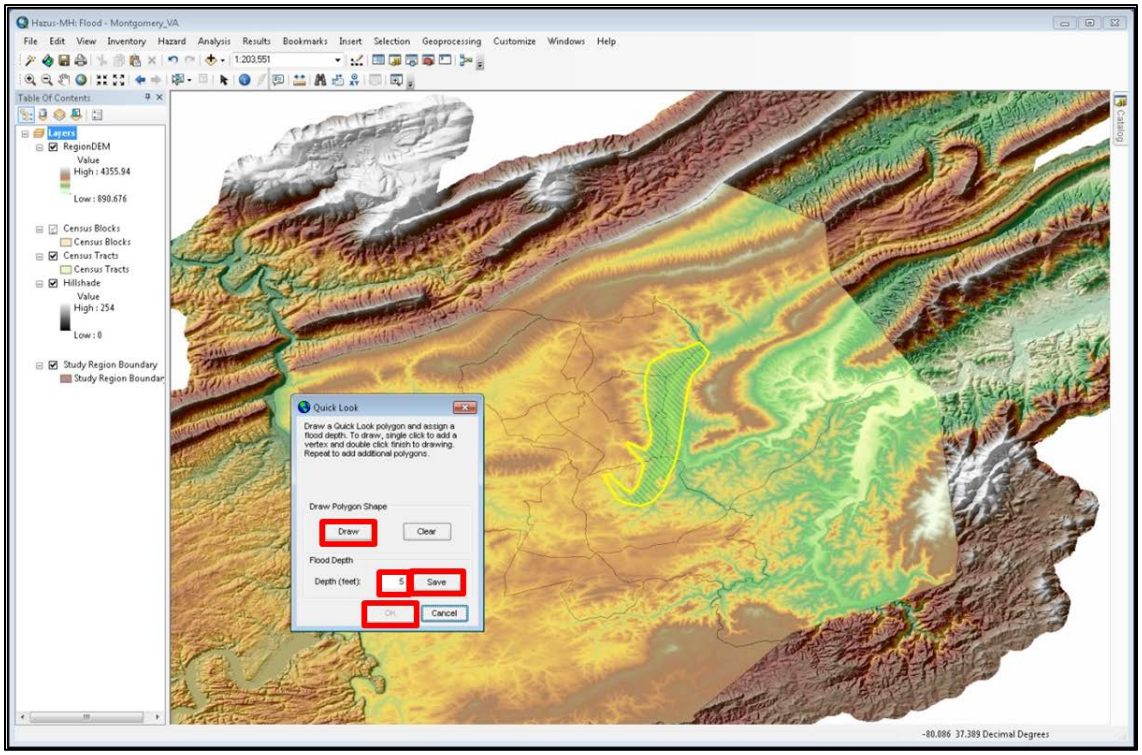
To conduct a **Quick Look** analysis, select **Quick Look** from the **Hazard / Quick Analysis** menu as shown in Figure 13-3. This will open the **Quick Look** dialog (Figure 13-4).

Figure 13-4: Quick Look Dialog



Click **Draw** in the **Quick Look** dialog. Using the cursor, draw a polygon with as many sides as desired, as illustrated with the yellow line in Figure 13-5. Double-click when the polygon is complete. Next, enter a **Flood Depth** for the polygon in the **Quick Look** dialog. Click **Save**, and then click **OK**.

Figure 13-5: Drawing a Polygon for Quick Look



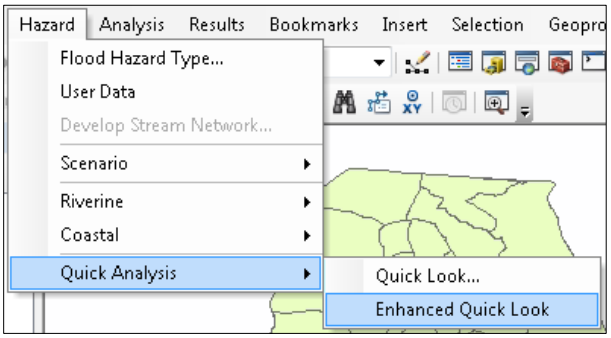
Only one **Quick Look** analysis can be performed in a given Study Region. Additional **Quick Look** analysis efforts will overwrite the results from the previous analysis. **Quick Look** will not run if a scenario is open. It is independent from the scenario(s).

After the **Quick Look** analysis has been completed, the Hazus window will show a depth grid of equal flood depth in the location where the user delineated the floodplain boundary.

13.2.2 Enhanced Quick Look

To conduct an **Enhanced Quick Look** analysis, select **Enhanced Quick Look** from the **Hazard / Quick Analysis** menu as shown in Figure 13-6.

Figure 13-6: Enhanced Quick Look Menu



The **Enhanced Quick Look** window will appear (Figure 13-7). From the dropdown menus, select the **Vertical units** and **Vertical datum** of the polygon representing the floodplain boundary. Browse to the appropriate file locations for the DEM and single continuous floodplain boundary polygon, as illustrated in Figure 13-8. Click **OK** to start the analysis.

Figure 13-7: Blank Enhanced Quick Look Window

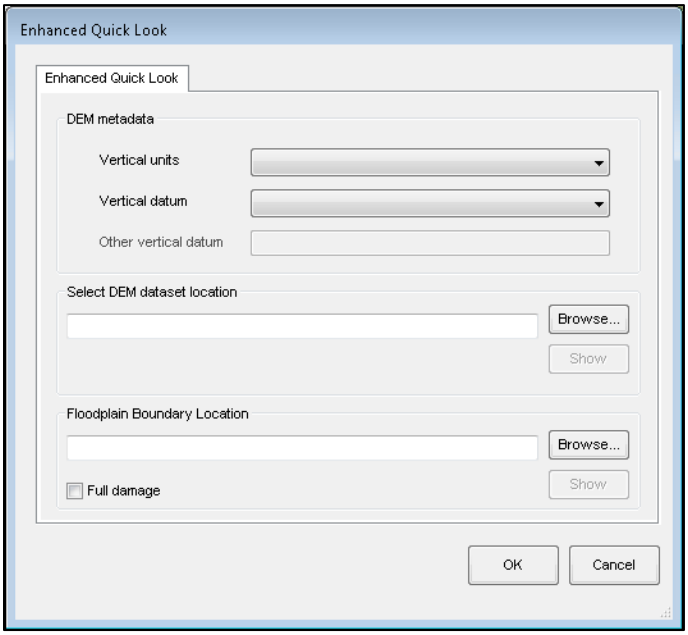
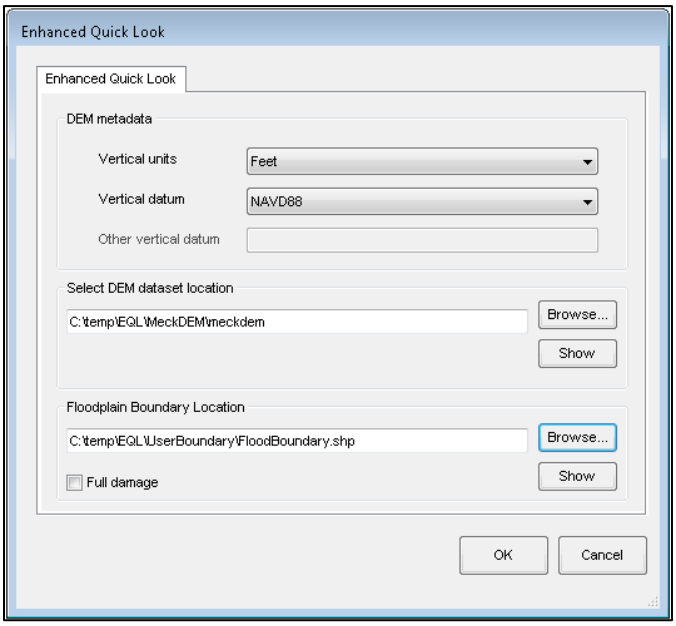


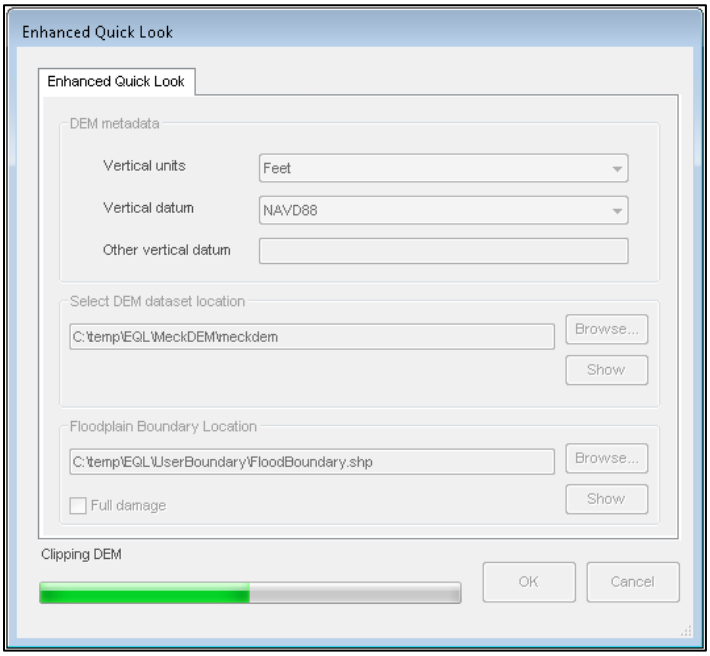
Figure 13-8: Completed Enhanced Quick Look Window



While the **Enhanced Quick Look** analysis is running, a status bar, shown at the bottom of the **Enhanced Quick Look** window in Figure 13-9, will indicate the level of progress of the analysis.

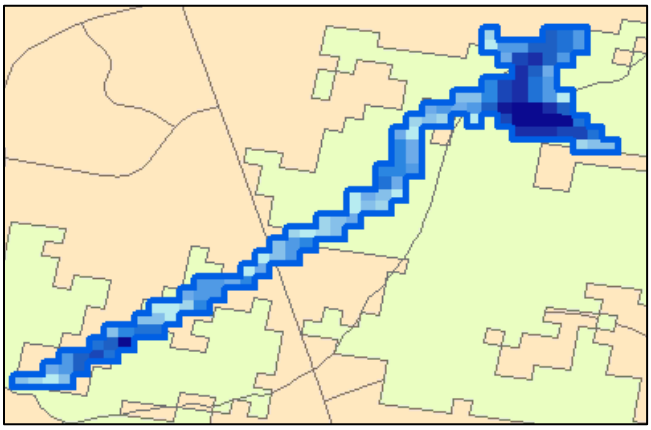
Only one **Enhanced Quick Look** analysis can be performed in a given Study Region. Additional **Enhanced Quick Look** analysis efforts will overwrite the results from the previous analysis. **Enhanced Quick Look** will not run if a scenario is open. It is independent from the scenario(s). If the user selects the **Full damage** checkbox, the Flood Model will make flood depth assumptions to maximum damage levels.

Figure 13-9: Enhanced Quick Look Window Status Bar



After the **Enhanced Quick Look** analysis has been completed, the Hazus window will show the imported floodplain boundary with a depth grid of varying depths within the boundary, as shown in Figure 13-10.

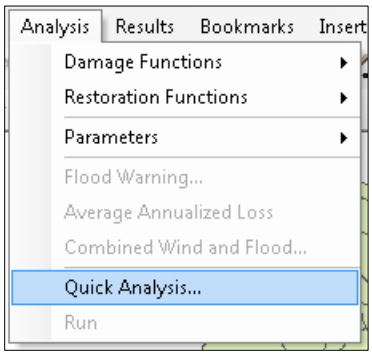
Figure 13-10: Example of Enhanced Quick Look Flood Depth Grid



13.3 Run Losses for Quick Analysis

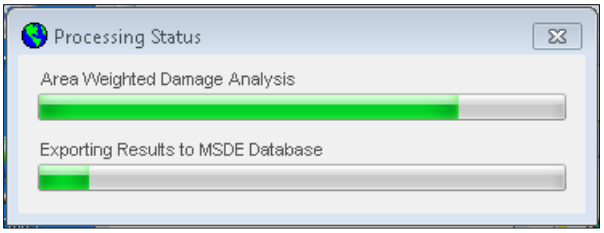
To run losses for a Quick Analysis after completing either a **Quick Look** or **Enhanced Quick Look** analysis under the **Hazard** menu, open the **Analysis** menu and select **Quick Analysis** (Figure 13-11).

Figure 13-11: Quick Analysis Menu



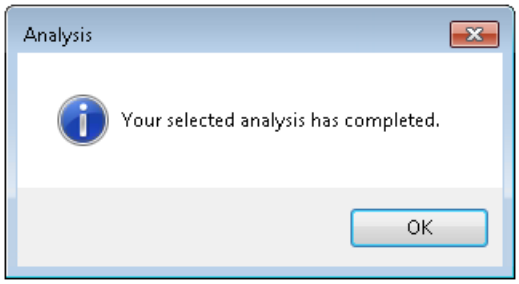
A progress bar (Figure 13-12) will appear as Hazus performs a flood loss analysis

Figure 13-12: Quick Analysis Progress Window



A notification (Figure 13-13) will appear once the flood loss analysis (only for GBS data) has been completed. Click **OK**.

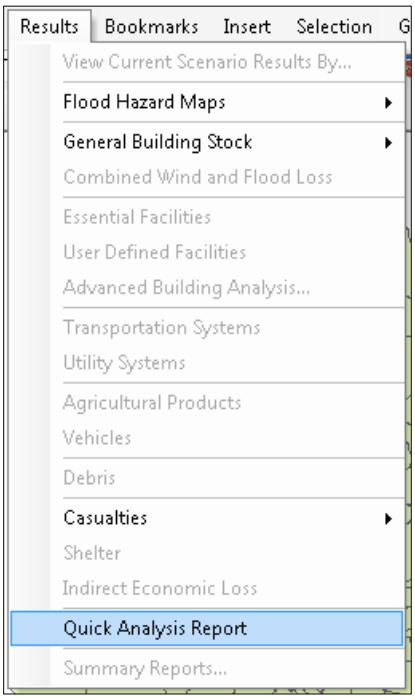
Figure 13-13: Quick Analysis Completed



13.4 Generate Quick Analysis Loss Report

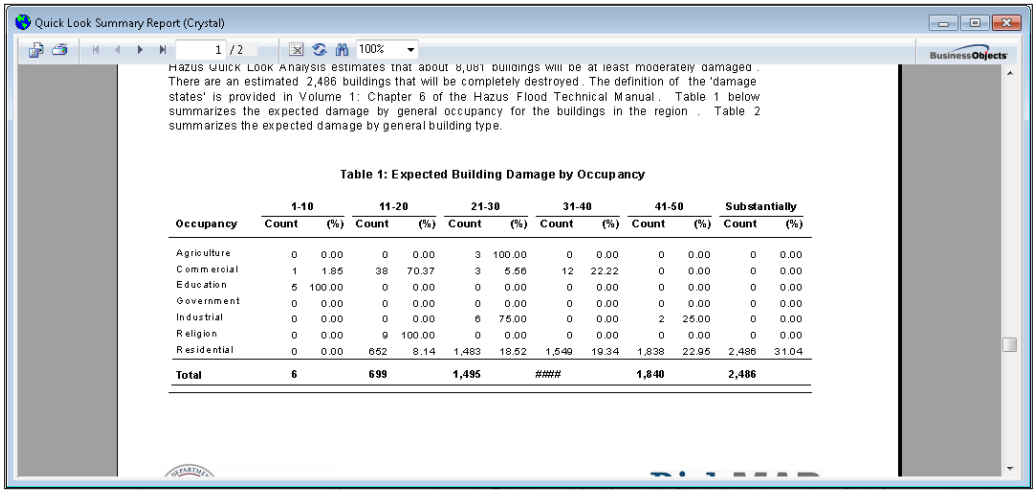
After running the loss analysis for **Quick Look** or **Enhanced Quick Look,** the user will be able to review the loss results by generating a special report exclusively for the Quick Analysis. This report is created by selecting **Quick Analysis Report** from the **Results** menu (Figure 13-14). This report provides the only way to access the loss results for a **Quick Analysis**.

Figure 13-14: Quick Analysis Report Menu



The **Quick Look Summary Report** (Figure 13-15) consists of two-page report summarizing the GBS results.

Figure 13-15: Quick Analysis Summary Report



14 Acronyms and Abbreviations

.dat	hurricane surface wind file
.fGDB	file geodatabase file
.FLT	floating-point binary
.hpr	Hazus Packaged Region, file extension used for exported Hazus study regions
.IMG	IMAGINE file
.mdb	geodatabase file
.TIF	tagged image file
DEM	digital elevation model
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FIT	Flood Information Tool
GBS	General Building Stock
GIS	geographic information system
HEC-RAS	Hydrologic Engineering Center's River Analysis System
Hurrevac	hurricane evacuation tool
NAVD	North American Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
RES1	Single Family
SLOSH	Sea, Lake, and Overland Surges from Hurricanes (model)
SWAN	Simulating WAves Nearshore (model)
SWEL	stillwater elevation
UDFs	User-Defined Facilities
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
WHAFIS	Wave Height Analysis for Flood Insurance Studies

15 Glossary

Advanced Level 2 analysis. An Advanced Level 2 analysis improves Level 1 results by considering additional data that are readily available or can be easily converted or computed to meet methodology requirements.

Advanced Level 3 analysis. An Advanced Level 3 analysis requires effort by the user to develop and update information concerning the underlying engineering and loss analysis parameters in Hazus. This type of analysis incorporates results from engineering and economic studies carried out using methods and software not included within the methodology.

Average annualized loss (AAL). The AAL is the mean value of a loss exceedance probability (EP) distribution. It is the expected loss per year, averaged over many years.

Basic Level 1 analysis. A Basic Level 1 analysis is the simplest type of analysis requiring minimum effort by the user. It is based primarily on data provided with the software (e.g., census information, broad regional patterns of foundation distributions, no floodplain code adoption).

Coastal flood hazard. Flooding hazards along the coast that have additional hazards due to wind or wave action.

Depth-damage functions. A way of expressing expected flood damages for various types of buildings, their contents, or their functions at different water depths. For floods, this relationship is expressed as depth versus percentage damage to the element being considered.

Depreciation parameters. The parameter for the depreciation of buildings is based on the age of the building. These parameters are used to determine the depreciated exposure of a census block.

Deterministic scenario. Considers the impact of a single-risk scenario.

Digital Elevation Model (DEM). A data file that contains digital representations of cartographic information in raster form. DEMs consist of a sampled array of elevations from a number of ground positions at regularly spaced intervals.

Direct economic loss. Direct economic losses begin with the cost of repair and replacement of damaged or destroyed buildings. However, building damage results in a number of consequential losses that are defined as direct economic losses.

Erosion. The collapse, undermining, or subsidence of land along the shore of a lake or other body of water. Erosion is a covered peril if it is caused by waves or currents of water exceeding their cyclical levels that result in flooding.

Essential facilities. Facilities that, if damaged, would present an immediate threat to life, public health, and safety. As categorized in Hazus, essential facilities include hospitals, emergency operations centers, police stations, fire stations, and schools.

First floor elevation. This is the elevation of the top of the lowest finished floor in a building. The relationship between the first floor elevation and the Base Flood Elevation at a site determines the extent of flood risk.

Flood Information Tool (FIT). The FIT is an ArcGIS extension separate from Hazus that can be used to create flood hazard data for import to Hazus. The data are prepared outside of Hazus and then imported into the model. For more information regarding FIT, see the *Flood Information Tool User Manual.*

Floodplain. Any land area susceptible to being inundated by floodwaters from any source.

Forecast. To calculate weather trend in advance of a future storm with uncertainties.

General Building Stock (GBS). Building database that includes square footage by occupancy and building type, building count by occupancy and building type, valuation by occupancy and building type, and general occupancy mapping.

Hazard. An act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or thing.

Hazardous materials facilities. Facilities housing hazardous materials such as corrosives, explosives, flammable materials, radioactive materials, and toxins.

Hazus. GIS-based risk assessment methodology and software application created by FEMA and the National Institute of Building Sciences for analyzing potential losses from floods, hurricane winds and storm surge, earthquakes, and tsunamis.

High Potential Loss Facilities. Facilities that, if damaged, could result in a high threat to life or release hazardous materials. Examples include nuclear power plants, dams, and military installations.

Lifeline systems. Utility systems that provide essential services for communities. Examples include roads and highways, rail, potable water, and wastewater systems.

Loss ratio. Loss as a fraction of the value of the local inventory (total value/loss).

Mitigation. Action to reduce the potential loss of life and damage to property by reducing the impact of disasters.

Probabilistic scenario. Considers the associated impacts of many thousand potential storms that have tracks and intensities reflecting the full spectrum of Atlantic or Central Pacific hurricanes.

Replacement value. The cost of rebuilding a structure. This is usually expressed in terms of cost per square foot and reflects the present-day cost of labor and materials to construct a building.

Risk. Estimated impact that of hazard on people, services, facilities, and structures in a community.

Riverine flood hazard. Hazards related to or produced by a river.

Scenario. A scenario defines the specific stream reaches, or lengths of coastline for coastal users, and the hydrologic and hydraulic characteristics to be included in one analysis run.

Storm surge. The abnormal rise in seawater level during a storm, measured as the height of the water above the normal predicted astronomical tide.

Stream network. Delineated streams from a DEM in a study region.

Study Region. The county, watershed, or community being created for the analysis.

SWAN (Simulating WAves Nearshore). Third-generation wave model, developed at Delft University of Technology that computes random, short-crested wind-generated waves in coastal regions and inland waters.

Transportation systems. The lifeline systems that include airways, highways, railways, and waterways.

User-defined facility (UDF). Building at a specific location that is added to the inventory.

User-supplied inventory. Enhanced inputs that are produced by editing both the basic inventory and updating the model parameters.

Utility systems. The lifeline systems that include potable water, wastewater, oil, natural gas, electric power, and communication systems.

Valuation parameters. The parameters for determining the replacement cost value for a building type.

Vulnerability. The susceptibility of an asset to physical injury, harm, damage, or economic loss.